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Cabinets and Countertops



FROM THE EDITORS OF **Fine Homebuilding**

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Cabinets & Countertops

FROM THE EDITORS OF **Fine Homebuilding**[®]



The Taunton Press

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The Taunton Press

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CONTENTS



Introduction	3
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PART 1: CABINETS

An Inside Look at Kitchen Cabinets	4
Installing Kitchen Cabinets	14
Refacing Kitchen Cabinets	26
Frameless Cabinets with a Traditional Look	36
Traditional Cabinetry from a Modern Material	46
Hybrid Cabinet Construction	52
Installing Kitchen Cabinets	60
Making Heart-Pine Cabinets	68



Simple Frameless Cabinets Built on Site	74
Site-Built Kitchen	82
Building a Lazy-Susan Cabinet	90
Working with Melamine	98

PART 2: COUNTERTOPS

Make Your Own Laminate Countertops	108
Hardwood Edgings for Plastic Laminate	116
Building Concrete Countertops	120
Choosing Kitchen Countertops	128
Making a Solid-Surface Countertop	140
Credits	152
Index	153

INTRODUCTION

Some years ago, my friend Tom installed laminate counters in his sister's new kitchen. Lying on his back, half inside a cabinet, attaching the counters from below, he ran out of screws. Tom asked his sister to run to the truck. "Be sure to get the 2-in. screws," he warned, "Not the 2½-in."

She brought him the screws and left the room. Tom stood up, got his pliers and cut ¼ in. off one of the screws. He placed the screw tip on the counter, balanced upright, so that it looked like it had penetrated from below. Then he started yelling and cursing. "Damn it, I said get the TWO-INCH screws!" His sister ran back into the kitchen and looked at the "ruined" countertop in horror. Tom let her twist in the wind before he picked up the screw tip and went back to work.

I'd think that story was funnier if I hadn't once ruined a countertop myself. In my case, the screws weren't too long. I simply got overzealous with the drill—this was before cordless versions with umpteen clutch settings—and drove the screw halfway through the cabinet stretcher, cracking the Formica. As I learned, mistakes are costly when dealing with cabinets and countertops, typically the most expensive components in the most expensive room.

Whether you're building cabinets and countertops or installing them, always arm yourself with the best information possible. These 17 articles from past issues of *Fine Homebuilding* magazine were written by builders and represent the hard-won knowledge of professionals who have learned from their mistakes.

—Kevin Ireton, editor,
Fine Homebuilding

An Inside Look at Kitchen Cabinets

■ SCOTT GIBSON

At the giant KraftMaid™ cabinet factory just outside Cleveland, workers stand by with glue guns and pneumatic nailers as parts for a complete set of kitchen cabinets approach on a conveyor. Drawers, face frames, prefinished panels, shelves, and moldings arrive from all corners of the million-square-foot plant. Although the customer who ordered this kitchen may have taken months to plan its every detail, KraftMaid assemblers will put it together in 15 minutes. Cabinets are shipped about a week after the order has arrived.

Did you think your new kitchen cabinets would be hand-built by fussy artisans? Guess again. Cabinets are a \$6 billion industry, and they pour off assembly lines like hubcaps or lawn chairs. If that prospect unsettles you, consider a smaller company, one like Rutt® Custom Cabinetry of Goodville, Pennsylvania. Here, door panels are matched for color and figure, one board at a time. A specialist is standing by to custom-blend a paint color. The catch? Rutt charges more than twice as much, and you can count on waiting 40 or 50 days to get your order.

KraftMaid and Rutt are only two among hundreds of cabinet manufacturers. Yet they help to illustrate the many choices buyers will face before plunking down thousands of dollars for a new kitchen.

Manufactured Kitchens Fall into Three General Categories

To help make sense of what's available, the industry has traditionally divided cabinets into three grades: stock, semicustom, and custom. The labels don't mean as much as they once did, but they are still a good starting point.

Stock cabinets are at the low end of the market. Available in limited styles and finishes and with fewer options, stock cabinets are built in standard sizes in increments of 3 in. in width. They are manufactured and then stockpiled, without regard to who will buy them.



Semicustom cabinets are built to order, also on a 3-in. grid, and offer more choices when it comes to styles, accessories, and finishes. Materials may be of higher quality. Custom cabinets, such as those from Rutt, are built to fit the available floor space exactly with just about any option the customer is willing to pay for. They are the most expensive of all.

And then there are the small shops, the local cabinetmakers found in virtually every corner of the country. Working on one job at a time, these shops turn out cabinets designed for just one client. Detailing, construction, and wood selection may range from ordinary to exquisite. Yet these cabinets are not manufactured in the same sense as factory-built, mass-produced goods. Examples of that more individual work can be found throughout this issue.

Any cabinet is a sum of its parts, and the choices can seem overwhelmingly complicated. Assessing quality is not always easy. Many manufacturers submit their cabinets to the Kitchen Cabinet Manufacturers Association for voluntary testing and certification. Although the process is wide ranging and rigorous (roughly half of those seeking certification for the first time will flunk), it's not useful for comparing individual components such as drawers, doors, and cabinet boxes. And makers of high-end cabinetry may skip the test altogether.

Whatever the cabinet industry's tests show, it pays to buy cabinets that are carefully built from good-quality materials and hardware. To me, that means avoiding cabinets made from paper-coated panels or ones with thin shelves that bend under pressure. Drawers should open smoothly, without wobbling. A finish should be silky to the touch, without any visible sanding marks. In short, buyers should seek cabinets that look and feel as if they are solidly made.

Prices vary as widely as quality. Bottom-of-the-line stock cabinets for a kitchen of roughly 120 sq. ft. are available for less than

\$2,500*, not including countertops and installation. According to estimates provided by both KraftMaid and Merillat®, one of the country's largest cabinet manufacturers, a better-quality kitchen might range from just over \$5,000* to \$12,800*, depending on materials and accessories. A custom-manufactured kitchen can approach 20,000*.

The following pages look in detail at four manufactured base cabinets that are typical of what's on the market. More expensive often means more quality and a longer life. But getting the best value also should include a careful look at the many differences in construction, hardware, finish and materials.

Cabinet Boxes: Your Kitchen's Foundation

A salesman may call the cabinet French provincial, Shaker, or Arts and Crafts, but from a construction standpoint, manufactured cabinets are one of two types: traditional face frame or frameless. In a face-frame cabinet, a rigid frame made of ¾-in. solid wood is attached to the front of a plywood or particleboard box. Face frames create square door and drawer openings while adding strength to the cabinet and helping to keep it square during construction, shipping, and installation. Depending on the type of hinge used, some or all of the frame is visible when doors and drawers are installed. In a frameless cabinet, overlay doors and drawer fronts hide the cabinet box. Often made from melamine, which is particleboard covered by a thin layer of plastic laminate, these cabinet boxes are usually held together with dowels and glue.

The days of solid-wood construction are long gone, mainly because panel products such as plywood, particleboard, or medium-density fiberboard make a stronger, more stable cabinet at a lower cost. Upper and lower cabinet boxes are now typically constructed of particleboard topped with wood



veneer, vinyl paper, melamine, or the same kind of high-pressure laminate used on countertops. Boxes of veneer-core plywood, lighter and stronger than particleboard, also are available but often cost more. Whether plywood or particleboard, more expensive cabinets tend to use thicker material for cabinet boxes and shelves.

A solvent-based varnish is a common choice for kitchen cabinets. It's tough and durable. In cheaper cabinets, the top coat may look glossy and rough, with some sanding marks still visible. Many companies, however, offer sophisticated, layered finishes in many colors or wood tones.

(\$115)*

FRAMELESS MELAMINE IS INEXPENSIVE, EASY TO CLEAN

Frameless cabinets, such as this melamine base unit from LesCare Kitchens of Waterbury, Conn., use a full-overlay door and

drawer front that span the width of the carcass. Upgrading the door and drawer front to a more durable high-pressure laminate raises the price of this cabinet to \$180*.

1, 2 Carcase: Cabinet sides are $\frac{3}{4}$ -in. melamine-faced particleboard with a $\frac{1}{4}$ -in. back and a $\frac{3}{4}$ -in. floor. Parts are assembled with glued dowel joints and are reinforced with full-width stretchers.

3 Shelf: Held in place by adjustable plastic clips, the $\frac{3}{4}$ -in. melamine shelf is 12 in. deep, about half the depth of the cabinet itself.

4 Drawer: Sides of $\frac{5}{8}$ -in. melamine are doweled and glued together with a $\frac{1}{4}$ -in. bottom and a thermofoil drawer front (medium-density fiberboard wrapped in plastic).

5 Door: A full-overlay thermofoil door is hung on adjustable hinges that can be removed without any tools, making it easy to pop off the door for a thorough cleaning.



**(\$125)*
STOCK FACE-FRAME CABINET
MADE WITH LIGHTER MATERIALS**

This cabinet, made by Kitchen Compact of Jeffersonville, Indiana, uses a traditional face frame to reinforce the front of the carcass. In this price range, some materials are likely to be relatively thin with a simulated wood-grain finish.

6 Carcase: Materials include sides of ½-in. wood-veneer particleboard, and a back of ⅛-in. vinyl-covered hardboard. The cabinet floor is ¼-in. vinyl-covered hardboard that flexes under a load. Corner blocks that reinforce the cabinet are stapled in place, but not all of the staples hit their target.

7 Shelf: Not adjustable and only ½ in. thick, the 11-in. wide shelf is made of vinyl-covered particleboard.

8 Drawer: Sides are ⅜-in. fiberboard faced in a wood-grain vinyl with a solid drawer front of red oak.

9 Door: A wood-veneer panel is set in a frame of solid oak. Hinges cannot be adjusted.

**(\$300)*
FOR MORE MONEY,
A STURDIER CABINET**

This semicustom KraftMaid cabinet has several advantages over lower-priced alternatives, including heavier materials and more durable construction.

10, 11 Carcase: This cabinet box is made from ½-in. veneer-core plywood with a ⅜-in. plywood back and a fully finished interior. Two ⅞-in. plywood stretchers reinforce the top of the cabinet.

12 Shelf: A ¾-in. plywood shelf runs the full depth of the cabinet. Held in place by plastic clips, the shelf is fully adjustable.

13 Drawer: A dovetailed hardwood drawer box is made with ¾-in. sides with a ¼-in. bottom and a ¾-in. hardwood drawer front.

14 Door: The solid door frame of ¾-in. maple has a solid-wood panel on adjustable hinges.



(\$700)*

**TOP OF THE LINE,
WITH A PRICE TAG TO MATCH**

This Rutt Custom Cabinetry base unit has a sophisticated painted finish and an inset door, making it look more like traditional furniture-grade cabinetry. Good-quality hardware operates smoothly.

15, 16 Carcase: The cabinet box is made from $\frac{5}{8}$ -in. veneer-core plywood with a $\frac{1}{4}$ -in. veneered back of medium-density fiberboard. A full dust panel reinforces the top of the cabinet.

17 Shelf: Although the retaining clip on the shelf is plastic, the weight is actually carried by a concealed metal pin, which is stronger. Adjustable and 18 in. deep, the shelf is made from $\frac{3}{4}$ -in. veneer-core plywood.

18 Drawer: The drawer is made from $\frac{5}{8}$ -in. hardwood joined with glue and

dowels at the corners with top-quality undermount drawer slides. The drawer has a $\frac{1}{4}$ -in. bottom.

19 Door: A traditionally mortised and tenoned door frame has a beaded detail on the inside edge and is hung with decorative butt hinges, which are not adjustable.

Drawers: A Sturdy Box Can Take a Lot of Abuse

Few kitchen components get as much wear and tear as a drawer. Before the introduction of modern drawer slides, a wood drawer box ran on wooden runners fastened to the inside of the cabinet. Often overloaded and yanked on unmercifully in sticky summer weather, drawers had a hard life. Good drawer

Doweled hardwood drawer box.

Light and strong, this $\frac{5}{8}$ -in. box of yellow poplar is joined with dowels at the corners and comes with a $\frac{1}{2}$ -in. plywood drawer bottom. That may be overkill in a narrow drawer, but a bottom this thick won't sag. Self-closing Blum undermount drawer slides are completely hidden and perform flawlessly.

Dovetailed hardwood.

Always the darling of the cabinet trade, a dovetailed drawer should last a long time. This one has sides of $\frac{3}{4}$ -in. hardwood and a $\frac{3}{16}$ -in. plywood bottom (a heavier drawer bottom would be better in a wider drawer intended for heavy objects). Undermount slides are out of the way, but they do not operate as smoothly or seem as sturdy as those made by Blum.

Marginal materials and construction.

Drawers like these are unlikely to give you a lifetime of dependable service. Faced with a drawer front of red oak, the drawer box is $\frac{3}{8}$ -in. medium-density fiberboard faced in wood-grain vinyl and joined with nails and glue. The $\frac{3}{16}$ -in. drawer bottom flexes easily under pressure. Even when new, the three-quarter drawer slide did not operate smoothly.

Doweled melamine. Typical for a frameless cabinet, this drawer box is made of $\frac{5}{8}$ -in. melamine, doweled at the corners, with a $\frac{1}{4}$ -in. bottom. The three-quarter extension epoxy-coated slide (this one made by Blum) operates smoothly. The gap between the applied drawer front and the front of this box should not be there.



slides incorporating plastic or metal rollers have eliminated much of that stress, making drawer construction less of an issue than it used to be. Even so, a drawer made of under-size material and running on cheap slides will be a never-ending source of irritation.

Solid hardwood traditionally has been the material of choice for good-quality drawer boxes. One big advantage is that the material does not dictate the joint that will be used to join the corners of the box. Solid wood can be dovetailed, doweled, biscuited, or dadoed, and a raw edge will never show. Many drawers also are made from engineered wood: veneered plywood, particleboard, melamine, or medium-density fiberboard. These drawers, common in frameless cabinetry, are often glued and doweled together. Raw edges must be banded. Plywood or melamine drawers certainly can be durable, but the material should be at least ½ in. thick. Avoid drawers made from thin, vinyl-covered particleboard and nailed at the corners. They feel flimsy, and they are more likely to come apart over time.

A standard drawer slide is an epoxy-coated, three-quarter extension unit rated at 75 lb. But full-extension slides, rated to 100 lb. and allowing access to even the back of the drawer, may be available as an upgrade. Undermount slides stay out of sight and, like other hardware, come in various levels of quality. The best are made from heavy-duty materials and quiet, smoothly operating rollers or ball bearings, such as the Tandem slide by Blum®, used on Rutt cabinets.

Drawers made from wood parts are by far the most common, but metal drawers also are available. One variety found in some frameless cabinetry has epoxy-coated metal sides attached to a standard melamine drawer front. The drawer side incorporates part of the slide mechanism.

Where To Buy a Kitchen

Manufacturers sell their cabinets through a retail network that includes building-supply stores, lumberyards, and stores specializing in kitchen and bathroom cabinetry. Larger cabinet retailers offer more variety, and those located near big home-improvement centers such as Home Depot® may offer everyone the prices that once were reserved for builders. If you have a particular cabinet brand in mind, the company can provide the name of a nearby retailer.

Driving from store to store is a time-honored way to shop, but doing some homework on the Internet first can help. Many manufacturers maintain their own Web sites where you can browse product offerings, learn more about how their cabinets are built, and find out where to buy them. One place to start is with a search engine such as www.dogpile.com or www.askjeeves.com (or whatever your favorite might be), where a search for “kitchen cabinets” will turn up companies all over the country. Content can range from specific information, on construction techniques and materials to collections of glossy photos. Some cabinet-manufacturing companies offer interactive sites that will help you to design a kitchen layout and to choose various accessories.

For lists of manufacturers, try www.buildingonline.com or www.kitchen-bath.com. Lists are organized so that you can search for a smaller company in your region. Another good resource is www.nkba.org, the home page of the National Kitchen and Bath AssociationSM, an industry trade group. You'll find design tips, budgeting information, and industry links for cabinets and other products. The Kitchen Cabinet Manufacturers Association's site (www.kcma.org) details the association's certification process for kitchen cabinets, valuable information for anyone in the market for a new kitchen.

A step up in a wood design.

This maple KraftMaid door has a solid wood raised panel and a smoother, less brassy finish than the door on a budget cabinet. The cope-and-stick joinery is essentially the same. The color and figure of the maple pieces used in both the panel and the frame of this door are not perfectly matched.



A stock frame-and-panel door.

A solid red oak frame surrounds a veneered panel in a door typical for a budget cabinet. Frame pieces are joined at the corners in a cope-and-stick pattern, a standard door joint. The panel is a very thin wood veneer over particle-board, not solid wood. Some sanding marks are evident on the inside of the door.



Thermofoil doors have a core of engineered wood.

A traditional frame-and-panel lookalike, this door is actually a vinyl-like plastic formed around a core of medium-density fiberboard milled by a computer-controlled router. Unlike other kinds of laminated doors, this one has only a single seam. MDF is heavy and stable.



Cabinet Doors Are a Visual Focal Point

Manufacturers devote a lot of attention to the doors on their cabinets for good reason: Along with drawer fronts, these parts are dominant visual elements in any kitchen. A single company may offer dozens of door styles. Many cabinet manufacturers do not build their own doors, buying them instead from vendors such as Conestoga Wood Specialties Inc. in East Earl, Pennsylvania, which makes some 5.5 million doors a year.

On frame-and-panel doors, virtually everyone now uses what's called a cope-and-stick joint in which the interlocking edges of the frame parts form the glue joint. Although this joint might horrify traditionalists, it is by now time-tested and strong enough. Be wary of any door showing gaps in the joinery. Raised door panels may be either solid wood with a profile milled into the outside edge or engineered wood faced in a thin wood veneer. Profiles will be crisper, and panels more durable, when of solid wood. Thermofoil doors mimic frame-and-panel styles but are made of engineered wood covered in plastic.

Some doors have mitered corners, like a picture frame, which are doweled or together. Seasonal wood movement makes this type of joint more likely to open up than other designs, just like mitered door and window casings.

Most kitchen cabinets have overlay doors, meaning the doors overlap the door opening. A full-overlay door covers the front of the cabinet completely. Because the doors are slightly bigger than their openings, overlay doors don't require any fitting. Less common are inset doors, which are housed in the door opening. When closed, inset doors are flush with the face of the cabinet, making the cabinet look more like a piece of furniture.

Overlay doors are usually hung with cup hinges, which are hidden when the



Easy on and off: Another cup hinge design allows door to be popped off without tools.



No adjustments: This economy hinge offers no door adjustments, and it flexes under a load.



Adjustable cup hinge: This cup hinge allows door to be adjusted in two directions.



Traditional Butt hinge: A furniture like hinge on this door is set into a mortise in the frame.



door is closed. Cup hinges allow the door to be adjusted in several directions, making alignment easy for manufacturer and buyer alike. Better hinges have more adjusting points, and some allow the door to be popped off the cabinet without using tools.

Door hinges can be a trouble spot for cabinets. According to the Kitchen Cabinet Manufacturers Association, failing hinges are one of the most common reasons that cabi-

nets flunk certification tests. So it pays to check them carefully when looking for cabinets. Avoid hinges that have too much play or feel flimsy.

**Note prices are from 1999.*

Scott Gibson is a freelance editor who works from his home in Maine.

Old-style detailing in a painted door. This pine door uses more traditional joinery. Its sand-through finish relies on layers of color and paint, plus sanding, to mimic the effects of years or hard use. The satin finish is silky to the touch.

Installing Kitchen Cabinets

■ TOM LAW

Well, there you are, just walking into a new kitchen with freshly painted drywall. Or maybe you're remodeling, and you've spent the last few days gutting the kitchen. But now you've got a clean slate to work with. The kitchen cabinets are in cardboard boxes, and all you have to do is unpack them and fasten them to the wall, right? Easy, tiger.

Kitchen cabinets are like carry-out food: A lot can go wrong with the order, and you don't want to be five miles down the road when you discover that something's missing. Before you begin installing cabinets, check all the boxes. Make sure you have everything you need and that the cabinets are what the customer ordered.

Take a close look at the walls and the floor—they're probably not as flat as they appear. You'll have to compensate for any imperfections because the cabinets take precedence. You don't distort a straight cabinet to fit a crooked wall.

Here, I'll discuss the methods I use to install cabinets when conditions are less than perfect, and believe me, they usually are.

Know the Room Conditions

Every installation begins with a check of the floor and the walls for the carpenter's guiding principles: plumb and level, straight and square. I use a straightedge and a level to see how the floor goes. The goal is to locate high and low spots because one of these spots will be the starting point for the cabinet layout, ultimately determining the height of the countertop.

I also use the straightedge to check the walls for straight and plumb. If there is a corner, I check it for square. Although serious flaws are uncommon, minor problems like spackle buildup often appear.

Marking the Wall and the Floor

To get over the fidgets of starting the job, I mark the cabinet layout on the wall. Marking the layout helps me visualize the finished job.



Marking the base-cabinet line.

Starting from the high or low spot on the floor, the height of the base cabinets is marked on the wall, then the mark is transferred around the room with a water level. The line is also a reference point for laying out the upper cabinets.

To begin with, I decide whether to use the high or low spot on the floor for my starting point. Choosing the high spot probably means that only one base cabinet will sit directly on the floor; all the others will be shimmed up. Using the low spot means that most of the cabinets will have to be scribed to fit the irregularities of the floor (more about scribing later). It's easier to use the high spot because it's easier to shim up than to cut off, but the determining factor is countertop height. Usually a countertop is 3 ft. from the floor.

Countertops themselves are normally 1½ in. thick, so the base cabinets are 34½ in. high. I mark this height on the wall above either the high or the low spot on the floor, whichever I've chosen as the starting point. Then I transfer that mark around the walls using a water level (see the photo above). I use the water level to mark the cabinet height at each corner, then I strike a chalkline between the marks. If you don't have a water level, a conventional spirit level and a straightedge will do.

After the base-cabinet line is marked on the wall, I mark the location of the indi-

vidual cabinets. I usually don't mark full plumb lines (the vertical lines) for each cabinet; I just make check marks along the base-cabinet line to indicate the width of each cabinet.

The face-frame stiles on most cabinets project beyond the sides ⅜ in. to ¼ in., which allows the stiles of two cabinets to be joined tightly without the sides of the cabinets bumping together. I mark each cabinet's actual size (its width from stile to stile) on the wall and then subtract the amount the stiles protrude to locate the back of the cabinet accurately.

I also use the base-cabinet line as a reference for laying out the upper cabinets. The space between the upper cabinets and the countertop is usually between 16 in. and 18 in. When measuring up from the base-cabinet line, I add 1½ in. for the countertop. Then I mark the wall to indicate the bottom of the upper cabinets. I double check to see that the top of the upper cabinets is the same height as the top of any full-length cabinet, like a broom closet or a pantry unit. If it isn't, I adjust the layout of the upper cabinets.

When I work alone, I find it awkward to hang upper cabinets first. By installing the base cabinets first, I can use them to support the upper cabinets.

Next, I mark the location of each upper cabinet, again with either check marks or full-length lines. Most of the time the upper cabinets are the same width as the base cabinets below them, and their edges align vertically. Cabinets must line up where an appliance, such as a refrigerator, protrudes into the upper-cabinet space. And by the way, you shouldn't add anything to the space indicated on the plans for an appliance. A 30-in. stove or refrigerator as called out on the plan will fit a 30-in. opening.

Some cabinets, such as those over refrigerators and stoves, don't come down as low as the other upper cabinets. And some cabinets, such as desk units, sit lower than the other base cabinets. I measure these cabinets and mark their locations.

Next I find the studs and mark their locations on the wall because I'll be fastening the cabinets to the studs. I mark stud locations with straight lines. Studs can be sounded out (where you tap the wall and listen for the higher pitch that occurs when you strike a stud) and probed for with a hammer and a nail, or they can be located with an electronic stud finder. If you use the hammer-and-nail approach, be sure to punch the holes where they'll be covered by cabinets.

It's okay to fasten a base cabinet to only one stud. Upper cabinets, however, are better off attached to two studs. Sometimes a cabinet isn't wide enough to catch two studs. I either attach narrow cabinets to their neighbors, or I might add blocking in the wall where it will be covered by a cabinet. I use a reciprocating saw to cut a hole in the drywall, then I insert a glue-covered piece of 1x that will span the hole. This block is the backing that I'll attach the cabinet to, so I make sure the hole is in the right place behind the cabinet.

Which Cabinets Come First?

The most important consideration when deciding which cabinets to set first, the uppers or the bases, is comfort. Some manufacturers suggest hanging the upper ones first because you can stand closer to the wall when the base cabinets aren't in the way. If you hang the upper cabinets first, it's sometimes recommended that you nail a 1x2 ledger strip on the wall to support the upper cabinets while you fasten them to the wall. It's a good idea if the backsplash will later cover the nail holes. But you wouldn't want to nail a ledger strip on a finished wall.

There are lots of ways to hold upper cabinets in place as you install them. You can buy or make various jacks and props, but it's been my experience that when hanging upper cabinets first, it's better to have two people doing the work—one holding, one fastening.

When I work alone, I find it awkward to hang upper cabinets first. By installing the base cabinets first, I can use them to support the upper cabinets (more on this method later). Plus the base cabinets are more complicated because they have to be fitted to both the wall and the floor, so I start with them.

Start From a Corner

It's much easier to start in a corner and work out of it than to put yourself in one. Most corner cabinets have their backs cut on a 45-degree angle, so setting them into an out-of-square corner is easy. If the cabinet has a square back, spackle buildup will probably have to be sanded down, but there are times when the only thing to do is cut away the drywall or plaster to get a square-back unit in place.

Because most corner cabinets have cutaway backs, they tend to shift around and are difficult to set in place. One way to shore up corner cabinets is to attach cabinets to each side and then push all three into place as a unit.

Another thing about corner cabinets with cutaway backs is that they often require a ledger strip along the wall to support the countertop. I nail a piece of 1x stock along the base-cabinet line to support the countertop in the corner.

Scribing a Cabinet

When a base cabinet—corner or otherwise—is installed, it must be set level and plumb. If the floor isn't level, there are two ways to get that base cabinet level and plumb—shim it or scribe it. Shimming is much easier; I just slip shims under the cabinet until it's level and at the proper height (see the photo at right). When the top is level, I check all the sides; as long as the cabinet is square, the sides should be plumb no matter how I place the level. Exposed shims and gaps are often covered by a vinyl base; sometimes there's a separate toe-kick board that's scribed to fit the contours of the floor. If I'm installing base cabinets over a wood floor, I hide the shims and the gaps with shoe molding.

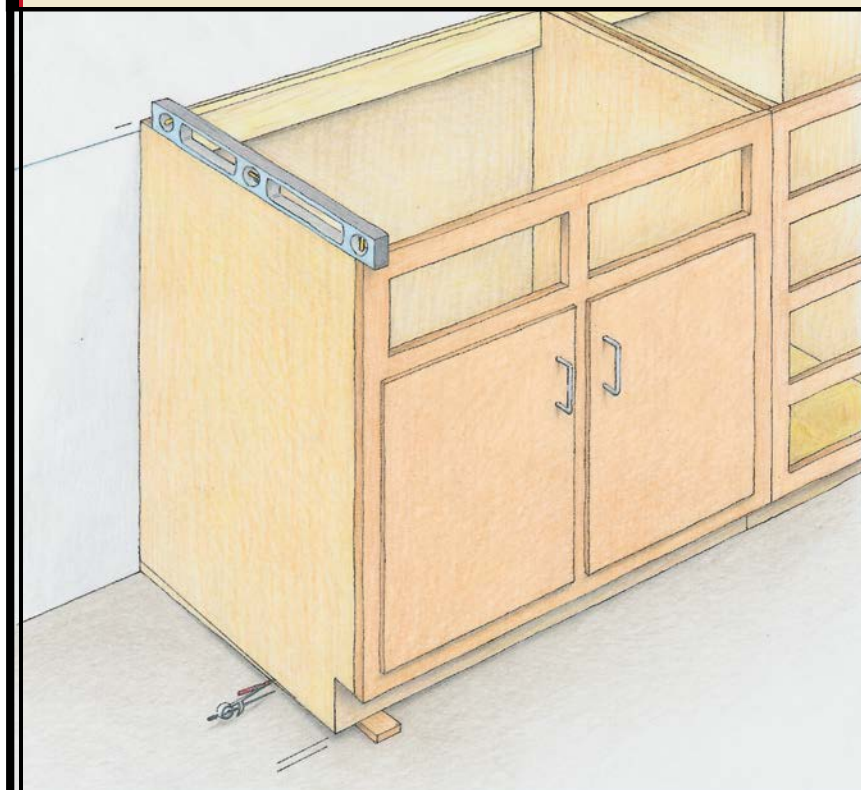
If the top of the cabinet is above the lay-out line even before I shim it, scribing is necessary. To scribe a cabinet to the floor, I bring the cabinet as close as I can to where it belongs in the kitchen, then shim it level. I set my scriber (or pencil compass) to the amount the cabinet extends above the line and scribe the cabinet at the floor (see the drawing at right). I cut the bottom of the cabinet at the scribe line. When I replace the cabinet, it sits level with the base-cabinet line.

When the side of a cabinet is exposed, it must fit perfectly against the wall. The side panels of many cabinets project beyond the back panels. These cabinets are easy to scribe to a wall. First, I level the cabinet, then set the scriber to the widest space between the cabinet and the wall and scribe both sides. I remove the cabinet, cut the sides to the scribe lines, then reinstall it. In some kitchens a decorative end panel is used to dress up the exposed side of a cabi-



Shimming a cabinet. Shims are used to level a cabinet, but they also bring cabinets that sit in low spots of the floor up to the proper height. Here, the end cabinet of a peninsula is leveled.

Scribe the Cabinet at the Floor





Fitting an end panel. Some cabinets have a separate end panel that should be scribed to fit tightly against the wall. With the panel clamped in place, the author uses a pocketknife to hold a strip of wood for scribing. The wood strip, like a scribe or compass, holds the pencil a set distance from the wall. The scribe mark is made on masking tape.



Cutting the end panel. The author uses a handsaw to get a clean cut along the scribe line. A slight back cut ensures that the face of the end panel will fit tight to the wall.

net. Such panels are usually slightly oversized so that they can be scribed to the wall (see the photo above). If the cabinet has a flush back, however, scribing is impossible, so straightening the wall or shimming the back and covering the gap with molding is the only choice.

Installation Information

Now that I've talked about laying out and fitting cabinets to the floor and the wall, here's how I go about installing a kitchen. First I put the corner cabinet in place, shim it level with the base-cabinet line and, if necessary, scribe the cabinet to fit. Then I fasten the cabinet to the wall by driving screws through the mounting rail into the

wall studs. The mounting rail is a horizontal piece of wood at the back of the cabinet.

Screws need to bite into studs at least $\frac{3}{4}$ in., so I use 2½-in.- or 3-in.-long drywall screws. But you may prefer to use wood screws, which have thicker shanks, or use the screws supplied by the manufacturer. If there's a gap between the mounting rail and the wall right where I want to run a screw, I slip a shim into the gap to keep the back of the cabinet from distorting when I put in the screw.

After the first cabinet is in place, I bring the second one to it, level it, get the face frames flush by lining up the top and the bottom of the cabinet's stiles, then I clamp the stiles together.

When the stiles are flush and tight with each other, I fasten them with screws (see



Joining cabinets. Cabinet stiles are clamped flush and joined with wood screws before the cabinets are installed. Two wood screws hold the cabinets together, one near each hinge.



Aligning cabinets. A straightedge placed along a run of cabinets shows which cabinets must move in or out. Here, a cabinet is pried away from the wall and shimmed out.

the left photo above). I always drill pilot holes and countersink the screws. Usually two screws in each stile are sufficient. When the doors are closed, the screws are hidden, but I still try to make them inconspicuous when the doors are open by putting the screws close to the hinges. Once the adjoining stiles are screwed together, I screw the cabinet to the wall.

I install each succeeding base cabinet the same way—level it, shim or scribe as required, fasten the stiles, and then screw it to the wall. As the run of cabinets grows, I put a straightedge across the front of the cabinets to make sure they're in line (see the right photo above). I make any adjustments at the wall by tightening or loosening screws and adding shims.

Installing a Sink Base

Sink base cabinets with back panels may be more difficult to install because they might have to be bored for plumbing and electrical lines. If the cabinets on each side of the sink base are in position—even temporarily—I use them as reference points from which to measure the locations of pipes and wires. If the surrounding cabinets aren't in place, I mark the sink base-cabinet layout full size on both the wall and the floor. Then I can measure the pipe and wire locations from the layout lines.

If I drill holes in the back of the cabinet from behind, I complete them from the finished side to avoid tearing out the veneer. A little tearout isn't a big deal because the

plumber usually puts a finish plate around the opening that covers a rough cut.

Some sink base cabinets have no back panel; obviously it won't be necessary to drill holes if the pipes and the wires come through the wall. But sometimes they come up through the floor. And that's when the layout lines on the floor come in handy.

Installing Between Walls

When a run of base cabinets fits between walls, the dimensions may work out, and the cabinets will fit exactly. But more often than not, the cabinets will require some fitting.

If the total dimension of the cabinets is just slightly more than the space to be filled, I put all the cabinets in except the last one, and I leave the next-to-last cabinet unattached; that is, I don't screw it to the wall yet. I measure the space left for the last cabinet. Then I remove the next-to-last one and put the last one back in plumb and level. I scribe it to fit the return wall. The amount of material to be scribed off the last cabinet's stile will be determined by the space required for the next-to-last cabinet when it's replaced.

Once all the scribing and trimming is complete, I put the last cabinet in place, then push the next-to-last cabinet in place with a pry bar. I use wax paper between the stiles to help the cabinet slide in without marring the finish.

Installing Filler and Backer Strips

When a run of cabinets doesn't quite fill the space between walls, filler strips are used. A filler strip is simply a board of the same kind of wood and finish as the cabinets, and it gets screwed to a cabinet's stile to fill a gap. Sometimes cabinets can be ordered with wider stiles to make up the difference, but fillers are more common.



Fastening a backer strip. This strip of wood acts as a spacer to hold the corner cabinets far enough apart so that their drawers don't bump into each other.

To scribe a filler strip, I first screw it onto the cabinet stile, move the cabinet as close as possible to its final position, then I scribe, using the widest gap as the amount to cut off. I almost always leave a filler strip on a cabinet and cut the strip in place.

Backer strips are frequently installed at inside corners to keep cabinets as far enough apart so that drawers or drawer handles don't bump into each other. Because the cabinets have to be separated by the thickness of the drawer front and the hardware, fastening a backer strip to the abutting cabinet will increase the clearance (see the photo above). We'll run into an inside corner later when I talk about peninsulas. But right now, I've still got to hang the upper cabinets.

Installing Upper Cabinets

Like the base cabinets, upper cabinets should be installed level and plumb, with sides parallel and stiles screwed together. All of the cabinets should be fastened to the wall using the same screws as those used for the base cabinets. I like to drive two screws in the top mounting rail and two into the bottom mounting rail. I fill gaps between the wall and the cabinet with shims as needed.

When hanging big, heavy upper cabinets, I lighten the load by removing all doors and shelves, and I reinstall whatever I've removed when all the cabinets are set. Removing the doors before hanging the cabinets also makes it easier to clamp the stiles together before driving the screws.

Instead of holding the cabinets in place as I try to fasten them to the wall, I typically use some plywood props (see the drawing below) or adjustable cabinet jacks (see the photo below). I made two different-size props from $\frac{3}{4}$ -in. plywood; one prop is 17 $\frac{1}{4}$ in. high for a 16-in. spacing between upper and base cabinets; the other is 19 $\frac{1}{4}$ in. high for an 18-in. spacing (16 in. and 18 in. are the two most popular spacings between upper cabinets and base cabinets). The finish space between upper and base cabinets is 16 in. or 18 in.; the additional 1 $\frac{1}{4}$ in. on each prop makes up for the countertop that's not yet in place. The missing $\frac{1}{4}$ in. is shim space. I put a prop on a base cabinet and rest an upper cabinet on the prop. I use long shims to adjust the height of the upper cabinet to the layout line. (Some base

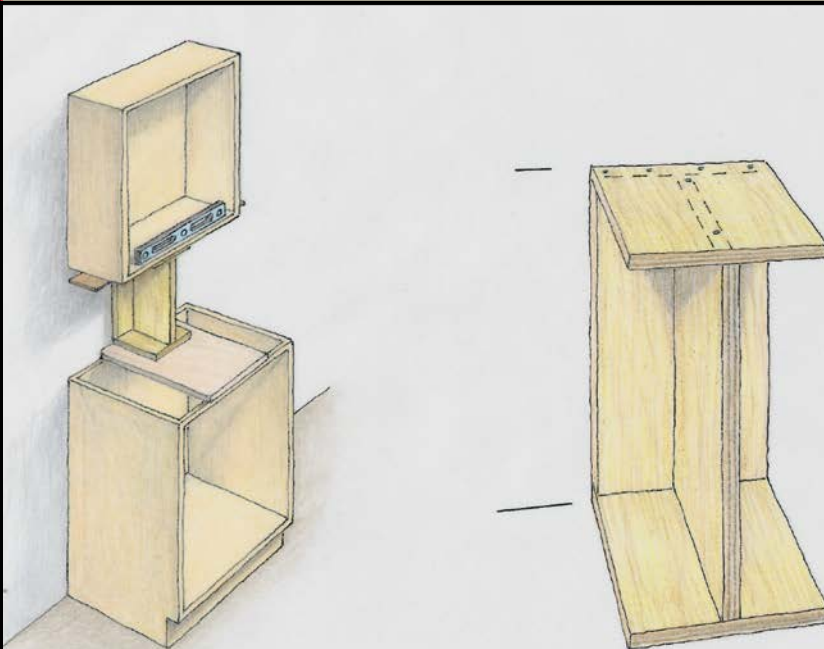
cabinets are open on top, so I lay a piece of plywood on top of these cabinets and use the shorter props.)

Just as I installed the base cabinets, I start with a corner cabinet and work my way out. Each succeeding cabinet is put into place on the plywood prop and shimmed level. Then I clamp and screw the stiles together. Finally I screw the cabinet to the wall and remove the prop. The fronts of the upper cabinets should also be checked with a straightedge and adjusted at the wall line, again either by tightening screws or backing them out and adding shims.

Islands and Peninsulas

When the kitchen plan includes an island or a peninsula, I make a full-size layout on the floor and check the squareness of the corner with the old 3-4-5 triangle. If the finish floor isn't down yet, I snap chalklines. But if the finish floor is in place, I don't want chalk everywhere, so I use masking tape to show where the cabinets go.

Hold Cabinets in Place with Plywood Props



Cabinet jacks consist of square steel tubes that slide inside each other; a cabinet sits in cushioned angle iron.

Installing European Cabinets

BY TOM SANTARSIERO

Cabinetry manufactured in Europe brought a new look and installation system to the United States. European cabinets are frameless—they have no face frame—and the shelf pins, the hardware mounting screws and the dowels that join the carcasses are drilled on 32-mm centers. Although many American cabinet manufacturers have incorporated the European look and construction system into their lines, few have fully incorporated its installation system.

European cabinetry has its own suspension and support hardware that makes installing cabinets fast and efficient, even if you work alone. Upper cabinets are hung from a steel rail that you screw to the wall studs. Base cabinets stand on adjustable leveling legs. Thanks to this hardware, plumbing and leveling cabinets are much simpler.

When laying out a European kitchen, I snap three level lines on the walls. One line indicates the top of the base cabinet; one line indicates the bottom of the upper cabinets, and the third line is for the upper cabinets' hanging rail. The height of this rail varies from brand to brand.

The hanging rail is a length of steel about 1¼ in. wide with an offset bend along the top edge. I predrill ¼-in. holes at 5 cm o. c. (about 2 in. o. c.; European cabinetry is all metric). I screw the rail to the wall through these holes with #14 2½-in. pan-head screws.

I install the upper cabinets first. They hang on the channel in the hanging rail via a pair of adjustable hooks (see the photos at right) that protrude from the back of each cabinet. Two set screws on each hook adjust the wall cabinets. One screw moves the cabinet in and out; the other moves the cabinet up and down. With this system, one person can easily hang and adjust wall cabinets.

When the hanging rail is above the cabinets, crown molding conceals it. If the hanging rail runs



Hanging an upper cabinet. A hanging rail screwed to the studs supports upper cabinets that have adjustable leveling hooks. This system allows one person to install cabinets.

behind the cabinets, I notch the back of the cabinets to fit over the rail. However, end cabinets with visible side panels aren't notched; the hanging rail stops against the inside edge of a visible side panel.

Once the upper cabinets are aligned, I bolt them together using joining bolts supplied by the manufacturer. Most European cabinets have partially bored holes inside along the front of the side panels. I clamp the cabinets together, finish drilling the holes and then pass the bolts through. The bolts are similar to small carriage bolts with a threaded cap or socket. All of the European cabinets I've seen come with these bolts. If the cabinets you're installing come without bolts, you can use short drywall screws.

Base cabinets have leveling legs that slip into plastic sockets on the bottom of the cabinet. The legs usually come with each cabinet, along with caps that cover adjustment access holes in the cabinet

floor. To level and plumb a cabinet, I either use the access holes to turn the legs with a screwdriver (see the photo at right), or I turn the legs by hand.

Europeans don't fasten base cabinets to the wall. The thinking is that because base cabinets are joined together and attached to countertops and appliances, the cabinets won't move. Also, Europeans take their cabinets with them when they move, so fewer screws going in during installation means fewer screws to take out on moving day.

So that my cabinets stay put, I fasten them to the wall. How I fasten them depends on the brand of cabinet I'm installing. True European cabinets are a bit shallower than the typical 2-ft.-deep face-frame cabinet. When I install European cabinets, I space them away from the wall slightly so that they'll be the right depth for a conventional countertop. Some manufacturers supply special particleboard blocks with their cabinets that are screwed to the wall and to the cabinet, serving as both a spacer block and a rigid means of attachment.

If the manufacturer doesn't supply blocking, I screw a 2x4 cleat to the wall at the level line and fasten the cabinets to the cleat. I use a length of predrilled metal angle inside each cabinet to keep the wall-mounting screws from pulling through the back panel.

Toe-kick material, usually particleboard covered with plastic laminate or veneer to match the cabinets, comes in long lengths about 7 in. wide. I rip it to the proper width. If the finish flooring is not in place, I rip the toe kick narrow enough to accommodate the flooring. Or better yet, I cut and install the toe kick after the flooring has been installed. A vinyl sealer strip (similar to weatherstripping) comes either attached or loose to seal the bottom edge of the toe kick to the floor.

After cutting the toe kick to length, I join inside and outside corners with plastic end caps. If corners join at angles other than 90 degrees, I miter the toe kicks and glue the joints. The toe kick is grooved on the back to accept knock-in clips that grip the leveling legs. To install the clips, I lay the toe kick



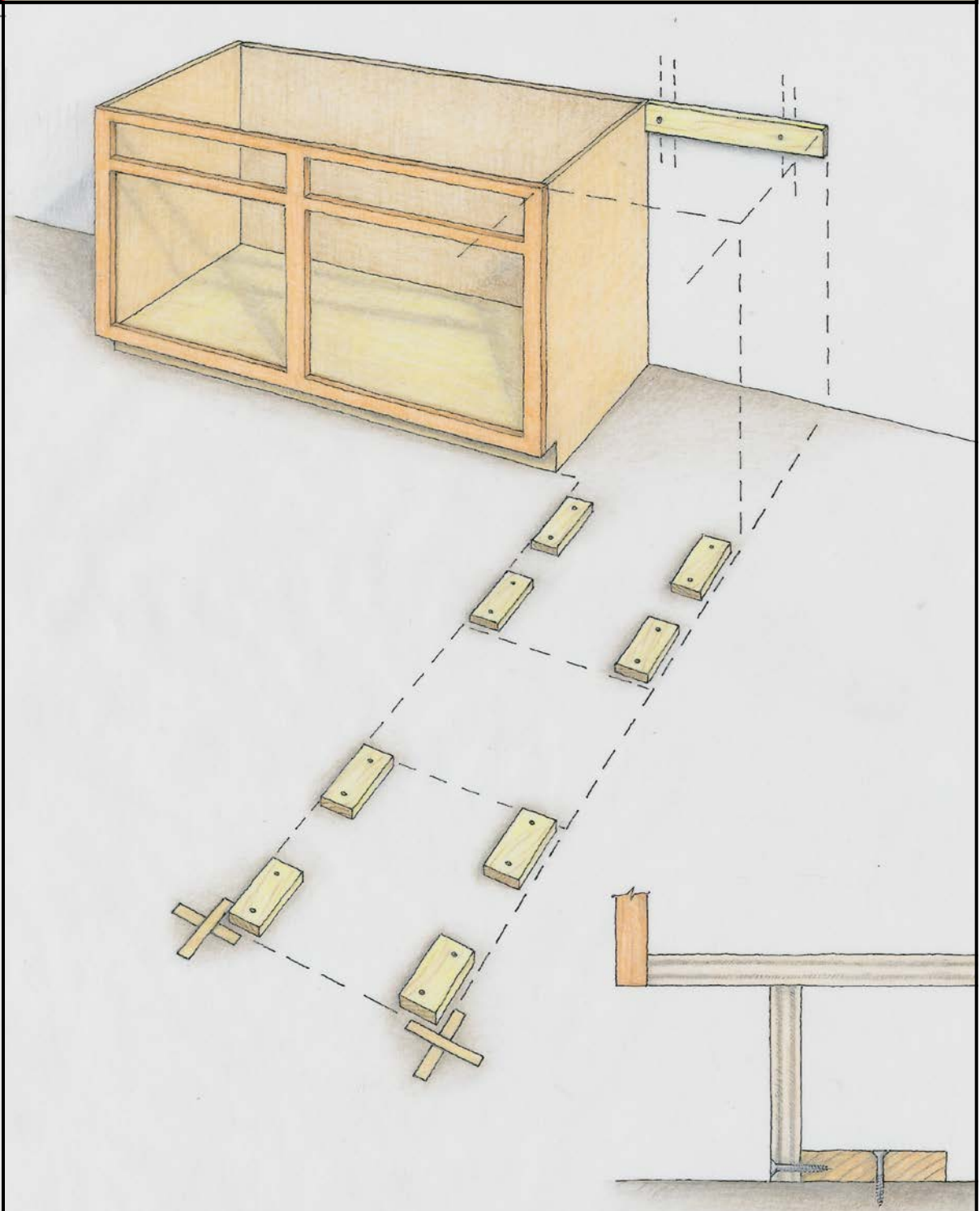
Adjusting the leg. You don't have to shim or scribe European cabinets because they rest on legs that are adjusted up or down with a screwdriver. The toe kick clips onto the legs; the clips are also adjustable.

face down on the floor in front of and aligned with the cabinets, and then I mark the location of every other leg and pop in the clips. The clips consist of a T-shaped knock-in and a U-shaped clip that slides over the knock-in. This combination allows some side-to-side adjustment of the toe kick once it's pressed onto the legs. End caps then snap onto the kick ends.

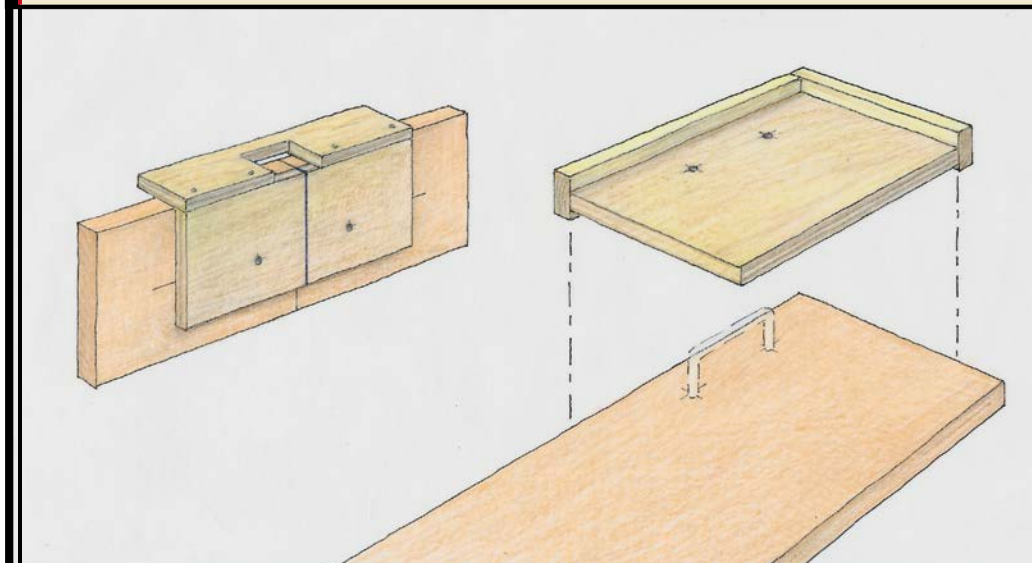
Island and peninsula cabinets are freestanding and are likely to tip and sway. To anchor these cabinets to the floor, I make L-shaped plywood brackets. The vertical side of the L is about two-thirds the height of the toe kick. I use these brackets in pairs, usually two pairs per cabinet. I screw one bracket to the floor and the other to the bottom of the cabinet, installing them so that the vertical faces of the brackets ride against each other. Then I set the cabinets in place, level them, join them, and screw the brackets together.

Tom Santarsiero is a cabinetmaker and president of The Kitchen Design Center in Montclair, New Jersey.

Secure Cabinets to the Floor with Blocks



Use Template to Drill Holes



An island or a peninsula should be secured to the floor, and I do it by screwing 1x blocks to the floor, then placing the cabinets over the blocks and screwing the cabinets to the blocks (see the drawing on the facing page).

Using my layout lines, I measure in from the edge of the masking tape or chalkline (which represents the outside of the cabinet) and mark the thickness of the cabinet's base. The new marks indicate where to screw the blocks down. Usually I just use a 6-in. to 8-in. block of 1x4 in each corner. Before I screw the cabinet to the blocks, I shim or scribe the cabinet so that it's plumb, level, and at the same height as the other cabinets. When an island or a peninsula cabinet is placed over the blocks, it can't be shifted side to side, and when the screws go through the cabinet into the blocks, it can't be lifted either.

Hardware and Handles

After I've replaced all the doors and the drawers, I install the hardware. If the holes for the pulls have been predrilled, it's easy enough to screw the hardware on. But if I need to drill the holes myself, and there are a lot of holes to drill, it's best to make a template (see the drawing above). I use a piece of plywood and glue a stop block at its edge, which holds the template in place on the door or the drawer.

I sometimes use masking tape to mark the hole centers. Masking tape makes pencil marks more visible, but I double check the marks by holding the handle up to them. I use a sharp scratch awl or punch to mark the hole, then drill it through. The center punch keeps the drill bit from wandering.

Tom Law lives in Westminster, Maryland. His video on installing kitchen cabinets is available from *The Taunton Press*.

Refacing Kitchen Cabinets

■ REX ALEXANDER

By the time she called me, Caroline McCary had already decided that her 32-year-old maple kitchen had to go. Caroline had antiqued the cabinets to a dark green a few years earlier (see the top photo on the facing page), and now she was tired of them. What she had in mind was a whole new set of cabinets.

Caroline runs a beauty parlor in her house and had heard about me from one of her customers. But the customer hadn't mentioned the fact that I reface kitchens—just that I build new ones. In fact, Caroline and her husband, Robert, didn't even know that refacing the cabinets in veneer was an option for them. But when I realized the cabinets were sound structurally, and the layout was sensible, I knew their kitchen was a perfect candidate for a veneer face-lift. And that would mean big savings for the McCarys.

I can make old cabinets look new (see the bottom photo on the facing page) for only two-thirds the price of new ones. What's more, the veneering process is far less disruptive for the customer than tearing out existing cabinets and installing new ones.



Shop demonstration. In his shop, the author cuts veneer roughly to size before demonstrating the refacing technique. The cabinet is from the kitchen shown on the facing page.

There are other advantages with the face-lifting process: First, you're recycling old cabinets, so you can feel good about taking some of the strain off the local landfill; and second, you're reducing your customer's exposure to the formaldehyde given off by the particleboard and plywood used in new cabinets. At the same time, a veneer face-lift is an opportunity for the homeowner to add some of those kitchen accessories that make life easier—things like self-closing door hinges, full-extension drawer slides or pull-out shelves, and lazy Susans. I get these items



A face-lift candidate.

Caroline McCary had worked in her kitchen for 32 years before deciding that the original maple cabinets, now antiqued to a dull green, needed replacement.



Same view, new face.

Working with existing cabinet carcasses and face frames, the author transformed Caroline's kitchen with oak veneer, new doors, and new drawer fronts.

from Direct Supply (2832 Vineland, Grand Rapids, Mich. 49508; 800-878-8704) or from Superior Distributing (918 Ft. Wayne Ave., Indianapolis, Ind. 46202; 800-622-4462).

The veneering process can transform a kitchen in a matter of a week or two. Specialized tools are few. And when applied with care, the veneer is both attractive and durable. Some of the work—like filling and sanding the face frames and finishing the new veneer—is done on site. Other work—such as making new doors, drawer fronts and end panels—takes place back in my shop. When all these elements are combined in the kitchen, the results can be dramatic.

Choosing Veneers

Wood veneers of almost all native American hardwoods, and of some imported species, are available from many wood suppliers.

I use Pluswood Indiana (P. O. Box 1028, Elkhart, Ind. 46515; 219-295-4105). Veneers come in a variety of widths, from $\frac{3}{4}$ -in. strips all the way to 24-in.-wide sheets.

Veneer is available in at least two pregglued varieties—pressure sensitive (see the sidebar on p. 28) and heat sensitive—as well as in the traditional types with no glue at all. I use heat-sensitive veneer, which I apply with a clothes iron, and I've found it is durable

Another Option: Pressure-Sensitive Veneer

HERRICK KIMBALL

My approach to veneer refacing includes basic steps that most kitchen-cabinet refacers are likely to follow: the removal of cabinet doors and the repair of imperfections in the existing frames; the application of $\frac{1}{4}$ -in. hardwood plywood end panels; and finally, the actual veneering. But I use pressure-sensitive veneer—or what's called peel-and-stick veneer—instead of the type treated with a heat-activated adhesive.

I use 10-mil-thick veneers with an adhesive backing made by 3M® (3M, 3M Center, St. Paul, Minn. 55144-1000; 800-362-3456). I buy it in 2-ft. by 8-ft. sheets. I simply cut the veneer to size, apply a bonding agent to the cabinet, peel off the backing paper, and stick the veneer to the surface I'm refacing. There is, however, one major caveat: pressure-sensitive veneer is very much like contact cement. That is, once it's stuck, there's not much chance of moving or adjusting it. If the veneer you apply goes on crooked, you'll need a sharp chisel and exceptional patience to get it off.

All the material I use for kitchen refacing—doors, plywood end panels, drawer fronts, and veneer—is prefinished by my supplier. That saves me a lot of time. There are many places to buy material, but the company I use is Concepts in Wood (4021 New Court Ave., Syracuse, N. Y. 13206; 315-463-8084).

Veneer the Stiles First

Once any repairs have been made to the face frames, and the surface has been sanded with 60-grit or 80-grit paper, I get ready to apply the veneer. The pressure-sensitive veneer sticks best to smooth, nonporous surfaces like old-fashioned metal cabinets. But let's face it—few surfaces are in perfect shape, so I use a bonding agent made by 3M called NF30. This is a water-based contact adhesive that is neither flammable nor noxious smelling. Just before I put on the veneer, I go over



the frames with a damp cloth to remove any dust. Then I paint on a coat of NF30 with a disposable foam brush and let it dry.

I prefer to veneer the inside edges of the stiles and rails as well as their faces. The entire face frame looks like it's new—even when the doors are opened. Fortunately, the veneer I use is flexible enough to wrap around a corner, and I don't have to cut separate pieces for faces and inside edges. I cut the strips, allowing $\frac{1}{4}$ in. extra in width and $\frac{1}{2}$ in. extra in length (I trim that excess off later). I start with the vertical pieces of veneer, so after cutting the pieces I apply a coat of NF30 to the stiles, including the inside edges (see photo 1). For the moment I don't coat the rails with any adhesive.

Before I apply the veneer to the stiles, I make a reference mark on the top and bottom rails. These marks will show me how much veneer must overhang the face to fold around the corner and cover the inside edge of the stile. With the marks made and the veneer cut, I peel the backing paper from the top of the veneer strip and lightly stick the veneer to the stile so that the inside edge is aligned with the reference mark (see photo 2).

Then, with one hand holding the piece taut and with the veneer lined up with the bottom reference mark, I press the top firmly into place. Then I slowly peel the backing paper down and off the veneer, pressing the veneer to the face frame as I go. To



Saving a tired cabinet. Beginning at left: A water-based bonding agent is applied with a disposable foam brush (1) and allowed to dry for a few minutes; a strip of veneer is lined up with a reference mark on the rail of the cabinet, applied to the stile (2), then bonded with a roller; the veneer is cut where it overhangs the cabinet rails, then it's folded around the edge of the face frame (3); excess veneer on cabinet stiles is trimmed with a sharp utility knife and a square (4).

ensure a good bond, I apply pressure with a hand roller or a stiff putty knife that has been covered in cloth.

The veneer must be sliced horizontally at both top and bottom rails so that it can be folded around the inside edge of the face frame. Using the rail as a guide, I make these cuts with a sharp utility knife. Once the cuts have been made, the veneer is folded around the edge (see photo 3) and smoothed to ensure a good bond. Because a roller won't fit into corners, I smooth inside edges with the shank of a fine-point nail set. Any excess veneer inside the cabinet is trimmed with a utility knife and sanded smooth.

I trim excess veneer extending onto the rails of the face frame. Because no bonding agent has yet been applied to the rail, the veneer can be peeled off with relative ease. I use a square against the rail as a guide and make the cut with a utility knife (see photo 4). As a last step, I trim off any extra veneer that hangs below the bottom of the frame. The stiles should now be complete.

The Rails Are Next

Horizontal surfaces are handled in much the same way: first the bonding agent, then the veneer and, finally, a roller. I find the exact length of the rail veneer simply by holding up a strip of veneer between the two veneered stiles and marking the strip. I make the marks with a utility knife and then cut the veneer on a cutting board with a square. Once cut to exact length, the rails are applied in the same way—with one notable difference. Instead of marking the face frame to show the correct overhang for the inside edges, I apply pieces of masking tape to the stiles and mark the tape. That makes removing the marks a snap.

When rails and stiles are veneered, I sand outside corner edges carefully with 120-grit paper. Then I stain any bare wood and spray on a couple of coats of aerosol lacquer. Where the veneer wraps around the edges of the face frames, it can crack slightly. If that's the case, I use 150-grit paper to knock down any high spots, then stain and spray finish the area.

On larger surfaces, the pressure-sensitive veneer can be unwieldy. Here's a tip: those bulletin-board push pins can substitute for an extra pair of hands while you scribe a sheet of veneer to the wall.

Herrick Kimball is a remodeling contractor in Moravia, N. Y.

The choice of wood can greatly affect the price of a kitchen face-lift.

enough to withstand the wear and tear of normal kitchen activities. In fact, in 15 years of kitchen face-lifts, I have not had a single callback because veneer loosened or was torn off during normal use.

But keep one thing in mind: The choice of wood can greatly affect the price of a kitchen face-lift. I use 1/4-in. plywood for end panels and door panels most of the time, and I've found it cost effective to use either birch or red oak. These plywoods are available in the northern Michigan lumberyards that I frequent, and they are economical. If you want something different, your supplier probably can order it. But ordering special plywood may be more expensive, and you'll have to buy solid lumber of the same species for drawer fronts and door frames. That matching solid lumber can cancel out the economies of veneer refacing.

Are the Cabinets Worth Saving?

Cabinetry that is still sound structurally can provide the right foundation for new veneer—but some cabinets aren't worth the effort. I look for well-built carcasses and face frames. The bottoms, sides, and backs of the cabinets should be in good condition and anchored to one another solidly. Adjustable shelves should work. I also check that face frames are firmly attached to the cabinet carcasses, or can be reattached easily, and that the face-frame joinery is flush and secure.

A set of kitchen cabinets, of course, is made up of a number of smaller units that are assembled when the kitchen is installed. If there are gaps between the face frames on adjoining cabinets, I usually can pull the cabinets together with drywall screws. But there are danger signs when inspecting a kitchen for a possible face-lift: 1/4-in. plywood cabinet bottoms that are bowed, loose, or falling apart; or face frames that are toenailed together. You might have to put more work into rehabilitating a kitchen like this than is profitable—for you or the customer.

The drawer joinery and glide operation should also be checked closely. Many older kitchens are blessed with hardwood drawers held together with dovetail joints. These older drawers often run on hardwood glides that may need only a little paraffin. Many other kitchens will include drawers of fir or pine with stapled lock joints that have failed over the years. Some of these drawers can be reinforced and strengthened, but others will have to be replaced.

Although the McCarys' cabinets were sound, the existing cooktop and range hood were near death, so they had to be removed, along with the base cabinet in which they were installed. I replaced the old cooktop with a new drop-in range flanked on both sides by narrow tray cabinets. In addition, we slated the old built-in wall oven for the scrap heap. In the cabinet opening that resulted from the oven's removal, I planned a pair of tall cabinet doors that would open to reveal two pull-out shelves for pots and pans. Finally, we agreed that I would install a pivoting blind-corner shelving system to make better use of an existing corner cabinet. None of these cabinet changes altered the kitchen's layout. But the McCarys did want to extend the cabinet peninsula to house a built-in dishwasher.

They wanted simple, easy-to-clean frame-and-panel doors of red oak. They chose matching red oak for moldings, end panels, and face frames. To finish off the room, Caroline wanted the soffit over the upper cabinets removed and 2 3/4-in. crown molding installed in its place. A plastic-laminate countertop with bullnose wood trim would complete the transformation.

Make Doors and Drawers or Buy Them?

I started compiling the lists and the drawings that would make the rest of the job easier. I drew a floor plan of the existing kitchen and

added the pertinent changes. And I made elevation drawings of the cabinets (1-in. scale) on graph paper to show actual openings for all doors and drawers. These drawings were helpful back in my shop, 20 miles away from the McCarys' kitchen.

There are many pieces that go into a kitchen face-lift, and I make accurate lists of all of them.

I took this process in several steps, beginning with the end panels. I also listed the lineal footage for the crown molding, the bullnose countertop trim and the baseboard, and I had my assistant double-check all measurements.

This is also the time to think about any special hardware that will be needed later—things like new drawer slides and pulls. I put in my order for that hardware, along with the plastic laminate and substrate for the countertop, so that the supplies would be on hand before the kitchen installation began. With these initial tasks completed and supplies en route, I could concentrate on door and drawer-front construction.

Although I like to make my own doors and drawer fronts, you can also order them from a supplier and install them yourself. There are many such companies (see Sources at right). Some suppliers can produce drawers and doors—as well as the veneer you will need—all finished and ready to install.

D-Day for Installation

One big advantage of a veneer face-lift is that the actual installation can be carried out quickly. In a small, uncomplicated kitchen, I can get most, if not all, of the work done in three days. On the first day I remove the countertops, the doors, and the drawers; install the new end panels; and veneer and stain the face frames. And I'm still home in time for supper. On the second day I lacquer the frames and apply new doors and drawer fronts. That leaves the third day for installing the countertops and the moldings. Larger kitchens may take

five days to complete once we get on the site; the McCarys' kitchen took a little longer than that because of extra cabinets and molding they wanted and because I, or my assistant, often worked there alone.

When the doors, the drawer fronts, and other parts and supplies were ready, we loaded our tools and converged on the McCarys' house. I had given the McCarys plenty of notice, so they had time to clean out the cabinets. I also prefer to have everything off the countertops, the refrigerator and stove out of the way, and all of the plumbing dismantled (if the countertop is to be replaced). Any patching or painting of walls or ceilings also should be done in advance.

Homeowners usually are around the house during the installation. So I keep dust and the general mess under control by blocking off door openings to the rest of the house and by using an exhaust fan to control dust and any finishing odors. It's also handy to have a shop vac on site.

When it's time to start, I remove the doors, the drawers, the countertop, the false drawer fronts, the valances, the cabinets that won't be used, and anything else that may hinder the veneering and finishing process. Then it's time to make sure individual cabinet units are fastened to each other securely. I plane any uneven spots in adjoining face frames and close any gaps between cabinets with drywall screws. If the cabinets can't be screwed together, I fill gaps with wood filler and sand down the surface.

Other work on the face frames may include filling in around new appliances with new wood or cutting portions out of existing frames so that new hardware will fit into place. In the McCarys' kitchen, for example, a new pivoting blind-corner shelf system called for a 14½-in. opening—2½ in. more than what was there. I had to cut the stile to accommodate the new shelf before any veneer was applied.

After these alterations have been made, I start by applying the new end panels. I cut the panels ⅛ in. oversize in width so

Sources

The veneers used in kitchen refacing are widely available—check the yellow pages or call your local lumber supplier. There also are many companies that make cabinet doors and drawer fronts. Your lumber supplier probably can direct you to one in your area. Another source of information is the *Custom Woodworker's 1993 Buying Guide*, which includes an extensive listing of door makers and veneer suppliers. The guide is available for \$25 by writing to Helen Kuhl, Custom Woodworking Business, 400 Knightsbridge Parkway, Lincolnshire, Ill. 60069; (708) 634-4347.

that they can be scribed to walls that may be slightly out of plumb. The edge of each panel should be flush with the face frame so that the veneer will iron on smoothly to both surfaces. End panels that are ¼-in. plywood may be attached with construction adhesive and hot glue—the hot glue holds the panels in place while the adhesive sets. If the new end panels are of frame-and-panel construction, they can be attached with screws from the inside of the cabinet.

Applying the Veneer

Before applying the veneer, I scuff sand the face frame with 120-grit paper in an orbital sander (see the top photo below), then wipe the frame clean. The Porter-Cable® #330

Scuff sanding. The author demonstrates the veneer technique in his shop on a cabinet originally part of the McCarys' kitchen. The first step is to sand the face frames with 120-grit paper to remove dirt, grease, and any other residue. Sanding also scuffs the surface to provide a good hold for the veneer that will follow.



Rough cutting the veneer. Alexander roughly measures strips of veneer and cuts them to length. On the job site, he cuts all of the strips for one cabinet, puts the veneer inside the cabinet, and moves on to the next one until he has worked his way around the kitchen.



Speed-Bloc sander is perfect for this operation because it allows you to sand into tight corners, and the sander won't fall out of your hand.

My veneer applicator is nothing more than a standard household iron that I plug in and set between perm-press and wool. The iron warms up while I cut the veneer roughly to size. Once the veneering begins, I like to keep at it without interruption, and that means having all the veneer pre-cut and the other tools I will need close at hand. The tools include a utility knife with a sharp blade, an edge-trimming knife (available from Tapes and Tools, P. O. Box 1195, High Point, N. C. 27261; 919-884-5371), a flexible 10-in. drywall knife, and a 3-in. J-roller. My roller comes from Woodcraft Supply Corporation (210 Wood County Industrial Park, P. O. Box 1686, Parkersburg, W. Va. 26102-1686; 800-225-1153).

As a rule, most kitchens require both 2-in. and 3-in. wide veneer strips. I buy mine unfinished in rolls; the material is easy to cut with sharp scissors. I work my way around the kitchen, cutting all the rail and stile pieces an inch or two longer than they need to be and putting the pieces in the cabinet for which they are intended (see the bottom photo at left). Where two 1½-in. face frames meet, 3-in. veneer can be used to cover both surfaces at once. Should a kitchen have areas that need more than 3-in. coverage, I use two pieces of 2-in. veneer and iron them on at the same time.

When I've got the pieces of veneer cut, it's time to apply them with the iron, which by now is warmed up. I iron with a slow, steady movement (see the top photo on the facing page). Stopping the iron may scorch the veneer, and while scorch marks can sometimes be sanded out, the damaged veneer often must be replaced. First I veneer the stiles (the vertical members of the face frame) and allow the veneer to hang over the inside and outside edges (I'll trim it later). I also allow the veneer to lap onto any adjoining rails (horizontal members),



Ironing on veneer. After the iron has warmed up, the veneer is bonded to the face frame by heat. The iron should not be held too long in any one spot, or the wood will be scorched. The author also is careful not to iron down areas that will later be trimmed—like the short section of veneer extending onto the cabinet rail immediately above the iron.

although I'm careful not to iron that part down yet. That excess, too, will be trimmed a little later.

Once the veneer has been ironed on, I roll it out to ensure a good bond (see the photo at right). Then I use the edge trimmer to slice off the excess on the edges (see the top photo on p. 34). A word of caution about that process: It's a good idea to keep an eye on the direction of the wood grain. Even though the veneer is thin, it can tear out if you try to slice against the grain. I read the grain on the veneer just as I would if I were planning a piece of solid lumber.

After veneer has been applied to the stiles, it's time for the rails. That veneer goes on the same way—overlapping the edges and the stiles. But I pay close attention not to iron the rail and stile veneers together quite yet. Once veneer is bonded to both rail and stile, I use the 10-in. drywall knife as a straightedge to cut the excess veneer at the rail-stile joint (see the bottom photo on p. 34). Because the drywall knife is flexible, I can register it against the inside edge of a stile and at the same time bend the knife over the face of the rail. I cut both layers of veneer at once. With the excess cut and peeled away, the rail veneer fits snugly against the stile veneer, and both can be ironed and rolled.



Rolling out the veneer. After the veneer has been ironed on, the author uses a roller to ensure a good bond. A few quick passes over the veneer are all it takes.

Once the veneer has been applied and trimmed, I sand all the edges. The bottom edges of the bottom rails are usually hard to sand because most toe kicks are only 3 in. or 3½ in. high—not enough room for the sander. I simply use a file in those tight spots and round over the edge slightly.

The veneer is now in place, the joints have been cut, and all of the edges have been slightly rounded. Next I test for any voids where the iron might have missed the heat-sensitive glue on the back of the veneer. Tapping lightly over the surface of the veneer with two fingers in a rhythmic motion, I listen for a hollow sound, which

tells me the veneer has not held. These areas are ironed and rolled again to ensure adhesion. I also test all the veneer edges to make sure they are secure and have been rounded over. I flick the edges with my finger to check for any looseness. After re-ironing and rolling any spots that need it, I sand the face frame with 220-grit paper.

Trimming the excess.

Alexander uses an edge-trimming knife to cut away the excess veneer that hangs over face-frame edges. It's a good idea to watch the grain in the veneer because tearout is possible if the edge trimmer is pushed against the grain.

Double cutting the overlap.

Using a 10-in. drywall knife as a flexible guide, the author cuts away excess rail and stile veneer in one pass with a utility knife. He then irons and rolls out the joint to fix the veneer permanently to the face frame.



Finishing the Face Frames

With the veneer firmly in place, it's now time to prepare the kitchen for finishing. I discard the veneer scraps and vacuum the cabinets, paying particular attention to the face frames. Because I spray my finishes, I also mask off all areas in the kitchen that might be damaged by finish overspray.

I like water-based finishes, especially if I'm doing the face-lift during winter. The new generation of water-based lacquers are manufactured without the volatile organic compounds (VOCs) that make nitrocellulose lacquer so dangerous outside a spray booth. And the water-based materials dry very rapidly, allowing me to apply multiple coats in a single day. I use Hydrocote® stains and finishes (The Hydrocote Co., Inc., P. O. Box 160, Tennent, N. J. 07763; 800-229-4937)

When I'm ready to apply the finish, I bring in my air compressor and lightly spray on any stain that might be required. I stain small sections at a time and wipe them down as I go. Spraying stain is quick, but hand application may be best when overspray would damage wallpaper or other surfaces. While the stain is drying (about one hour), I busy myself with other tasks like installing glides to drawers or hinges to doors. When the stain is dry, I begin applying the lacquer. I apply two light coats at a time and do that three times, so there are really six thin coats of lacquer in all. Between each of the three applications, I sand the face frames with 320-grit paper.

After the lacquer has been applied, it's time for another inspection of the face frames. Air pockets resulting from poor glue adhesion will really stand out now. They can be made to lay flat by heating them with a hair dryer set on high, followed by a quick roll.

Installing Drawers and Extras

With finishing out of the way, all of the hardware that makes a kitchen efficient and fun to use can be installed. That might include pull-out shelves, blind corner systems, or special tilt-up shelves for heavy kitchen equipment like mixers. I also fit new drawers and drawer glides and set any new cabinets that I've made.

At this point the drawers are just boxes—without their fronts. With the new drawer boxes in position, I drill two holes in the front of each box so that I can attach the drawer fronts. The holes are 1 in. from the inside front edges and centered top to bottom. To the outside of the drawer, I apply double-stick carpet tape to hold the drawer front in place while I make sure it fits. Then I use drywall screws to attach the face to the box.

Drawers that are in good condition need only new fronts. More often, however, older drawers don't have separate drawer fronts—the existing front also has a lip edge. If that's the case, as it was at the McCarys, I chuck a flush-trimming bit with a pilot bearing in my router and cut the lip off. New fronts can then be applied. Occasionally, a drawer also will need some type of reinforcement. If the drawer sides are pulling away from the front or the back, several repair methods may be used. Small wood screws may be enough to hold the sides together. Reattaching the sides with pneumatically applied staples or brads also may work. Another technique is to glue small triangular pieces into inside corners to reinforce failing joinery.

New Doors, Countertops, and Trim

Most homes have carpeted living rooms. This is a perfect staging area for the next part of the installation—hanging new cabinet doors. I finish the doors in my shop

before taking them to the kitchen for installation. Once at the job site, I line up doors face down on the carpet where the finish won't be damaged and, in assembly-line manner, install the hinges. Each door is then moved from the living room to the kitchen and applied to the appropriate cabinet.

Because the door hinges I use are fully adjustable (up and down and side to side), I simply open the hinges, eyeball their placement on the inside edge of the face frame, and screw them in place. Once the doors are hung, I use a jig (available from most woodworking suppliers) to drill all the holes for knobs or pulls in both doors and drawers. I also use felt cushions on inside edges of doors and drawers.

After that, crown molding, soffit trim, and baseboard all can be cut and nailed into place. The top perimeter of the McCarys' cabinets was accentuated with 2 $\frac{3}{4}$ -in. crown molding that was glued and nailed to a 1x that had been screwed to the top edge of the cabinets. I also dress up the toe kicks by gluing $\frac{1}{4}$ -in. oak plywood to the recessed surfaces. It is sometimes appropriate to make the toe kick as unobtrusive as possible, and I do that by painting a strip of hardboard flat black and gluing it in position. In other situations, I apply baseboard right over the toe kick—as was the case on one cabinet at the McCarys.

Because my shop can be far from a customer's house, it's easier to construct the countertop right on the job site. In the McCarys' kitchen, I used $\frac{3}{4}$ -in. high-density particleboard as the countertop substrate and covered it with plastic laminate. The countertop was edged with a $1\frac{3}{16}$ -in. oak bullnose trim that I made on the shaper. After scribing the counter to the walls, I secured it from below with drywall screws. Then I glued and brad-nailed the bullnose trim into place and finished up by filling all nail holes.

Rex Alexander is a cabinetmaker, specializing in kitchens. He lives in Brethren, Michigan.

TIP

Occasionally, a drawer will need some type of reinforcement. If the drawer sides are pulling away from the front or the back, small wood screws may be enough to hold the sides together. Also try reattaching the sides with pneumatically applied staples or brads or glue small triangular pieces into inside corners to reinforce failing joinery.

Frameless Cabinets with a Traditional Look

■ PAUL LEVINE

I had a little memory-jogging experience the other day when I visited a friend who rebuilds car engines. “Pull my finger,” he told me, but I knew that old joke. “No, really, take a look at this,” and he put his finger on a device he had bought to measure drill-bit diameters. The device has a needle gauge marked in 1,000ths of an inch, and every second or so, the needle jumped. “That’s my pulse,” he said. Marveling at the sensitivity of the new instrument, I remarked that 20 years ago I thought I needed that kind of precision in my cabinetmaking shop. Ah, the folly of youth.

I no longer rely on precise measurements and setups. Over the years I’ve developed a cabinet-building system in which, rather than trying to make a cut perfect the first time, I make the piece too big and then pare it down slowly to get the cut just right.

I’ve also learned to disregard nominal dimensions. For example, when making grooves to house $\frac{3}{4}$ -in. plywood shelving,

Frame-and-panel doors provide a traditional look. These cherry cabinets with a lacquer finish employ cup hinges, so the doors hang on the cases instead of from a separate frame. The moldings that frame the door panels emphasize the traditional appearance.



I take out the $\frac{3}{4}$ -in. dado, right? No. I ignore the nominal dimension and set the dado to $\frac{5}{8}$ in. Then I incrementally widen the groove until the plywood just drops in. The setup takes a little longer, but the results are great.

Here I'll describe how I use these methods to build frameless cabinets, also called European cabinets (see the photo on the facing page). Frameless cabinets have no integral face frames and use 32mm cup hinges and drawer slides. This hardware lets doors and drawers be attached directly to the case. It's the style of doors and drawer faces that can give frameless cabinets a traditional look.

The traditional look I'll build here is a full-overlay frame-and-panel door. Full-overlay doors cover the edges of the case, as opposed to half-overlay doors, which leave part of the case's edges exposed. If I were building a traditional cabinet with a face frame, I might leave that frame totally visible by using inset doors, which hang within the face-frame openings. But face-frame cabinets with inset doors and drawers are tougher to build and give you less storage space than the frameless cabinets I'll build in this article.

Loose-Tenon Joints Are Quick and Strong

In my small shop, I build doors first because they take up less space than cases. If I built the cases first, I'd be wallowing in them as I built the doors.

When I build a frame-and-panel door or drawer face, I join stiles and rails (the vertical and horizontal parts of the frame) with a loose-tenon butt joint (see the photo above right). This joint is as strong as a conventional mortise and tenon, yet it takes much less time to execute because I don't need any special tools, just a router and a table saw. In this joint the rails butt into the stiles, and both members are mortised so that a separate tenon may be slipped into these mortises like a dowel. After assembling the frames, I



Door-frame joinery features a simple, quick loose-tenon joint. A loose tenon ripped from solid poplar fits into mortises in the stiles and the rails. Mortises are cut with a $\frac{3}{8}$ -in. straight bit in a plunge router.

rabbet the inside edge, drop in a panel, and hold it in place with panel molding.

I use $\frac{5}{4}$ stock for frames not just because it looks good but also because the thickness gives more bearing surface for clamping. The thinner the stock, the more likely it is that a clamp may pull a frame out of flat. After jointing and planing the stock, I rip it into $2\frac{1}{2}$ -in. widths, then cut it to length on a chopsaw.

There's a $\frac{1}{16}$ -in. reveal all the way around the door or drawer face, which means its size equals the case dimensions minus $\frac{1}{8}$ in. If I'm hanging two doors in a single opening, the doors will be half the case width minus $\frac{1}{8}$ in. Because the rails butt into the stiles, the rails are cut 5 in. less than the overall widths just cited. I save a few cutoffs for setting up the mortising fixture.

Mortising Fixture Locates Mortises Accurately

With the best faces of the stiles and the rails facing me, I set the frames on a flat surface and mark across the center of each rail onto the stile. These marks indicate where mortises will go. The ends of the rails and the top and the bottom edges of the stiles get mortised.

I do the mortising with a fixture that I designed for use with a plunge router (see the sidebar on pp. 40–41). I clamp a stile

or a rail in the fixture and then run the router against the fixture's stop blocks to cut an oblong mortise.

I make all my mortises starting $\frac{3}{8}$ in. from the edges of the stock. Any less, and I could open up the mortise when routing the outside edge detail. Typically, mortises are $\frac{3}{8}$ in. wide, $1\frac{1}{16}$ in. deep and $1\frac{3}{4}$ in. long.



Loose tenons are tapped in with a mallet. Loose tenons are pared down on a table saw until they fit snugly in the mortises. Here, the tenons are inserted into the stile mortises, which have been coated with glue. The rails are then slipped onto the tenons.

Assembled frames are clamped with pipe clamps. It takes about a day for the frames to set up. Pressure blocks prevent clamps from damaging the frames. Clamps must be centered through the thickness of the frame, or they may pull the frames out of flat.



Pare Down Tenons Until They Just Slip into Mortises

Because the tenons are buried in the frames, they don't have to be pretty. They do, however, have to be strong and stable, so I make tenons from poplar, an inexpensive hardwood. I rip tenons from 4/4 stock on the table saw, deliberately ripping them about $\frac{1}{16}$ in. thicker than the mortise.

The strength of a loose-tenon joint comes from a tenon of perfect thickness. I get the right thickness by thinning tenon stock on a table saw or a planer until the tenon just slips into the mortise with light force.

The tenon's length and the width aren't as critical, so these dimensions are undersized to allow for glue runout and to compensate for any imperfections. I round over all edges of the tenon stock with a $\frac{3}{16}$ -in. roundover bit in the router and cut the tenons in 2-in. lengths.

Assembling the Frames

Now I put glue in all four stile mortises, swish the glue around with a stick to coat the inside walls of the mortise and drive in four tenons with a mallet (see the top photo at left). I also swab glue into the rail mortises and onto the ends of the rails.

Then I slip the rails onto the tenons and clamp the frame with pipe clamps (see the bottom photo at left). There should be excess glue at every joint; if no glue squeezes out, I didn't use enough glue. The clamps are positioned at the tenons to apply pressure through the center of the frame stock. If the clamps are too high or too low, they'll pull a stile out of flat.

Next, I scrape away excess glue. The joint will set up faster with this extra moisture removed, and it's easier to remove glue now than when it hardens. Then I set the frame aside to dry overnight.

A 35mm bit bores door frames for 32mm European cup hinges. The edge of the bore is 3 in. or less from the end of the door. The back of the door is bored, and the bore does not penetrate the frame.



Rabbet the Inside Edge to Hold the Panel

To get all the joints flush, I rough sand the frames with 80-grit paper on a random-orbit sander. When the surface is flat, I shape the inside and outside edges of the frame. I use an ogee curve on the outside edge. Although I use a shaper to cut this decorative edge detail, there are router bits that do the same job.

I shape a test piece to see if it will allow space for 32mm cup hinges. If the shaping bit cuts too deeply into the edge of the frame, it may cut into a hinge mortise. After shaping the edge, I move to the drill press and bore the back of the door frames for the 32mm cup hinges (see the left photo above). Next, I rabbet the inside edge of the frame. The depth of the rabbet depends on the thickness of the panel and the panel molding. I use a $\frac{3}{8}$ -in. bearing-guided rabbeting bit in the router (see the right photo above) and square the radiused corners with a chisel. Then I sand the frame up to 220 grit.

The center section of the door is called the panel; it's seated within the rabbeted



A rabbeted edge to hold the panel. Instead of a groove to house the panel, a rabbet creates a ledge against which the panel is seated. Rabbeting is simpler because it allows you to assemble frames first without the panel to complicate assembly. The rounded corners are squared with a chisel.

door frame. I make solid-wood panels from $\frac{1}{2}$ -in. stock, which, unlike thinner stock, has a substantial feeling that enhances the quality of my doors. I cut panels from a single piece of wide stock. Even 36-in.-wide cabinets, which are very wide, only require about $12\frac{3}{4}$ -in.-wide panels. Stock this wide and wider is readily available from any decent lumber supplier. Door panels are installed with the grain running vertically. I crosscut the panel stock so that it fits precisely in the frame, but I rip panels about $\frac{3}{16}$ in. narrower than the frame to allow for the panel to expand. Because I use such thick stock for panels, I rabbet the edges of the panel so that I can seat it and the panel molding in the frame. The panel's rabbeted edge interlocks with the frame's rabbeted edge like a shiplap joint.

I rabbet panels on a table saw with a dado blade, sending the panel on edge past the blade. I make several passes, deepening the rabbet until it's just deep enough for the panel molding to hold the panel snugly in place.

Custom Fixture Is an Accurate Guide for Plunge-Routing Mortises

A good loose-tenon joint depends on consistently sized, accurately placed mortises. I've devised a mortising fixture that guides my plunge router. With the fixture, I can cut consistently sized mortises in just the right spot so that stiles and rails line up. Once the fixture is set up, it takes about five seconds to cut a mortise. To make the fixture, you'll need about an hour.

Grooves in top of fixture house guide rails—The fixture's base is a piece of $\frac{3}{4}$ -in. plywood. A pair of hardwood rails in the top of the plywood base guides the router. These guide rails are parallel and slightly closer together than the width of my router base.

I installed the rails in grooves in the plywood. Holding the same edge of the plywood against the saw fence each time I made a groove resulted in two

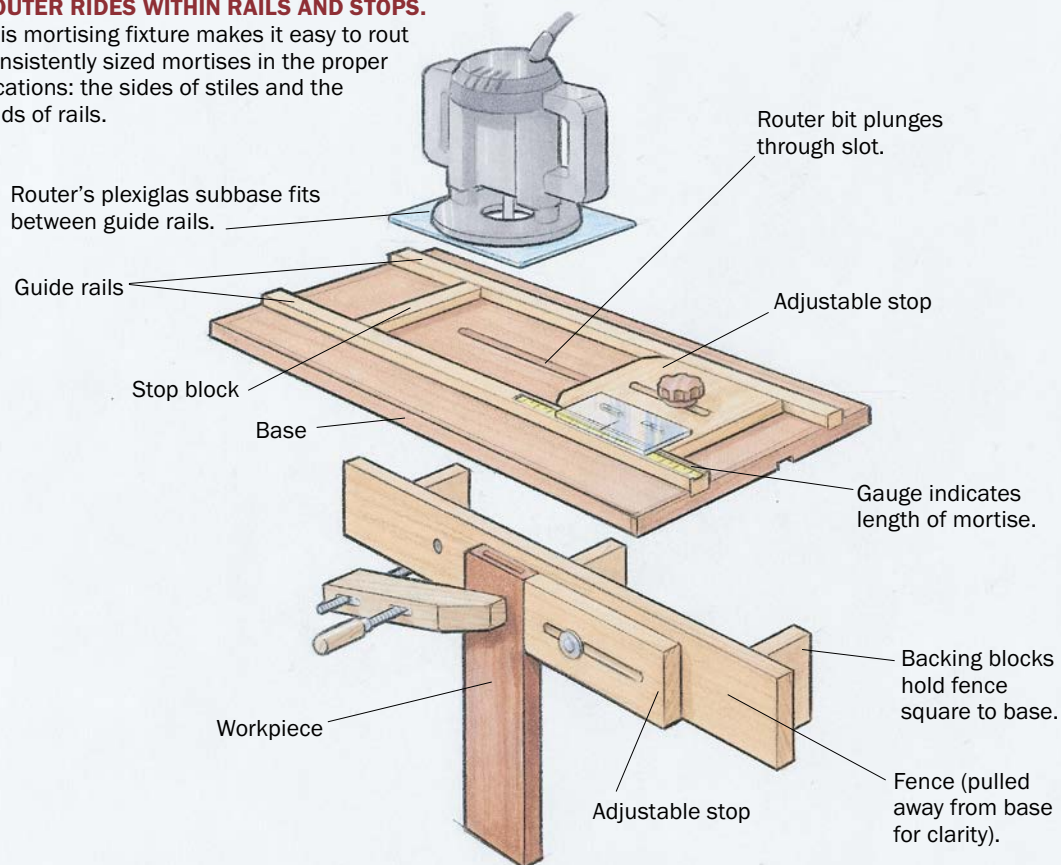
parallel grooves. I widened the grooves little by little until the guide rails just dropped into the grooves. After gluing the rails in place, I shaved one down until the router dropped easily between the rails.

About 6 in. from one end of the fixture, I glued and nailed a stop block. Then, with a router between the rails and against the stop block, I routed a 6-in.-long, $\frac{3}{4}$ -in. slot in the plywood base. This slot is the one through which I lower a straight bit to cut mortises.

An adjustable stop block at the other end of the base limits the length of the mortise. This stop block is a 6-in. length of hardwood that's been pared down in width to slide between the rails. I cut a $\frac{1}{4}$ -in. slot in the adjustable stop so that it can slide back and forth across a machine screw. The screw engages

ROUTER RIDES WITHIN RAILS AND STOPS.

This mortising fixture makes it easy to rout consistently sized mortises in the proper locations: the sides of stiles and the ends of rails.



a threaded insert in the base; tightening the screw clamps the stop in place. The corners on the front edge of the stop block are nipped off. These cutoff corners catch sawdust. The front of the stop stays clean.

Fence on bottom of fixture positions workpiece—On the bottom of the plywood base, I installed a fence to which I clamp stock when routing mortises. The fence's position is critical. If it isn't parallel to the guide rails, mortises will come out cockeyed in the stock. So I set the fence in a groove parallel to the guide-rail grooves in the top of the fixture. I chose one reference edge, which I registered against the saw fence each time I grooved the base, ensuring that all grooves were parallel. I made the fence groove wider and wider until the fence, a 3½-in. wide, ¾-in. thick length of hardwood, just dropped into the groove.

Because I work mostly with ¾-in. and 1-in. stock, I located the fence so that a ¾-in.-wide mortise is centered in ¾-in. stock. Thicker stock has an offset mortise. Then, to square the fence to the base, I installed three square backing blocks behind the fence. If the fence isn't square to the base, mortises won't be parallel to the face of the stock.

Workpieces are clamped on the fence against an adjustable stop block. The stop block does two things: It positions workpieces in the fixture automatically, and it holds rail stock square in the fixture.

The stop block is slotted so that it can slide across a machine screw. The screw engages threaded T-nuts, which are similar to eyelets installed about 6 in. from both ends of the fence. Having two T-nuts allows me to move the stop block to the other side of the fence to make the second mortise in the stiles.

Next, I calibrated the fixture. I set my router in the fixture against the fixed stop block. Then I laid a scrap of wood 1⅝ in. wide beside the router. I butted the adjustable stop into the scrap and marked the stop's position on the guide rails. With a ⅜-in. straight bit in the plunge router, whenever

the stop block is lined up with this mark, the router cuts a 2-in.-long mortise. I glued an old tape rule to a guide rail and then screwed a plastic gauge to the adjustable stop to indicate the length of a mortise.

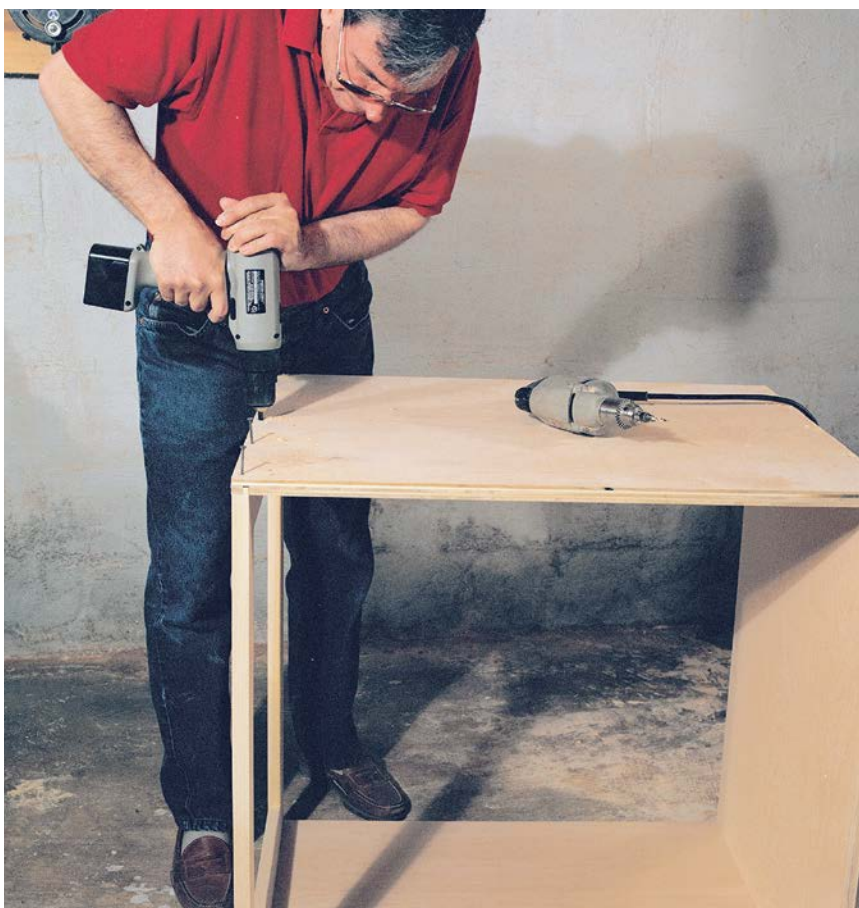
The last step was to figure out exactly where to clamp a workpiece in the fixture. I mortised a scrap in the fixture, removed the router, and marked in the fixture's slot to show the end of the mortise nearest the fixed stop. Then I marked the fixture so that when I clamp on a workpiece, the mortise starts ⅜ in. from the end of the frame stock.



Using the fixture. A quick side-to-side pass with a ⅜-in. straight bit in a plunge router cuts a mortise whose length and width are limited by the fixture's rails and stops. The author uses a Workmate® to clamp the fixture and the workpiece simultaneously.



Panel molding is rabbeted to fit over frame. The depth of the rabbet in the frame depends on the thickness of the panel plus the seated depth of the panel molding. The panel molding holds the panel in place.



Cases are assembled with glue and screws. With the case lying on its side, the side panel is screwed to the top frame. Tongues in the top frame and the bottom panel interlock with dadoes in the side panel. Small gaps between the tongues and the dadoes allow for glue runout.

Shaped to fit over the door frame and the panel, panel molding looks something like cove molding with a rabbet on the back edge (see the top photo at left). I make my own panel molding on a shaper, but you can get panel moldings milled up at a good lumberyard. I cut the panel molding on a chopsaw, mitering the ends, and then sand the molding and the panel by hand. Then I reset the panel and pin the molding in place. Remember that the panel should float freely; don't pin through it. If you don't have a pinner, use brads. After setting and filling the nail holes, the door is ready for finish.

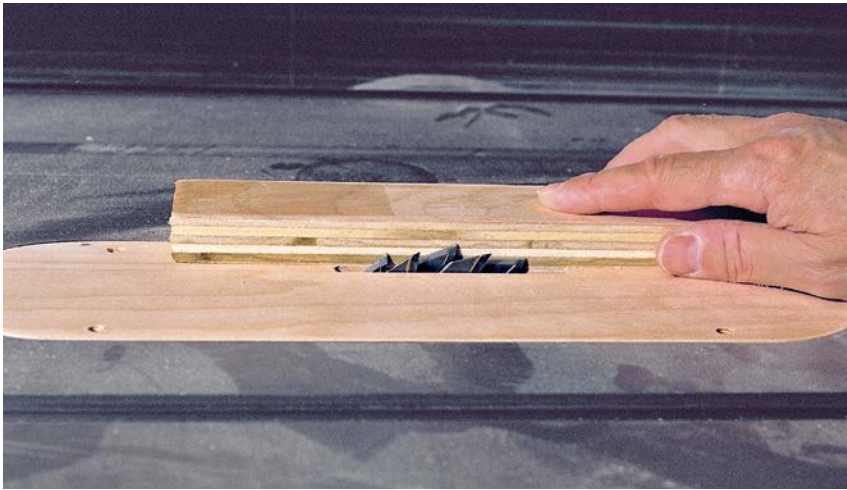
Frameless Cases Have Tongue-and-Dado Joints

I build $\frac{3}{4}$ -in. birch plywood cases and join the side panels to the bottom and the top frame with tongue-and-dado joints (see the bottom photo at left). This joint is strong, simple to make, and self-aligning, which means you don't have to mess around trying to get panels flush. The two side panels are dadoed, and tongues in the top frame and bottom panel fit into these dadoes.

A $\frac{1}{4}$ -in. plywood back panel is screwed to the case, and the exposed plies on the front edge of the case are edged with solid-birch banding.

Instead of a full top panel, my cabinets have $\frac{3}{4}$ -in. poplar top frames. The frames require extra labor. But they make the cases easier to move around because they're a little lighter than cases with a solid top, and the frame acts as a handle. Also, an open top provides access to the cabinet and lets light in the cabinet, a real bonus when installing hardware. These frames are the first things I make. I assemble them with a biscuit joint. I make the frames bigger than necessary. Then when I cut up the birch-plywood panels, I trim all of the parts of the case so that all pieces are the same dimensions.

Because standard cabinets are 24 in. deep, I rip 4x8 sheets of plywood in half and trim



Adjust the blade with a plywood scrap. The depth of the dado is ascertained by eye. Place a scrap of $\frac{3}{4}$ -in. plywood atop the throat plate and next to the blade, and set it to cut halfway through the middle ply.

the halves to a final width of $23\frac{1}{2}$ in., providing two fresh edges without nicks. Next, I cut all panels to length, usually 30 in. for the side panels, because I set the cabinets on a separate $4\frac{1}{2}$ -in.-high toekick structure. Widths of bottom panels vary with the kitchen design.

The tongue-and-dado joint is made on the table saw using a dado blade. I cut the dados first with a $\frac{1}{4}$ -in. dado blade. The dados run perpendicular to the grain along the top and bottom edges of the side panels.

When I'm cutting with a dado blade, it helps to have a throat plate, the removable portion of the saw table that sits around the blade, for the $\frac{1}{4}$ -in. dado. The throat plate supports the plywood's fragile veneer, reducing the risk of tearout.

The dado should go about halfway through the $\frac{3}{4}$ -in. plywood. To adjust the depth of the dado, I place a scrap of the plywood flat on the saw table against the blade (see the top photo above). I raise the blade until it reaches halfway up the middle ply.

The next step is to adjust the fence to get the dado the correct distance from the edge of the plywood. I move the fence about $\frac{1}{2}$ in. away from the blade and hold a piece of scrap plywood on edge against the fence over the blade. Then I adjust the fence so that the blade just pokes out a bit beyond the plywood (see the bottom photo above).

Now I check the setup by dadoing a scrap of plywood and holding another scrap on edge flush with the edge of the test piece.



The inside edge of the dado should be barely visible.

The mating part to this groove is the tongue, which is made along opposite edges of the top frames and the bottom panels. I cut the tongues with a $\frac{5}{8}$ -in. dado blade with the saw arbor cranked slightly lower than it was when I dadoed the side panels. At this setting, the tongue should leave a small gap at the bottom of the dado to allow for glue runout. When changing blades, I leave the height setting alone so that no time is wasted making test cuts.

Although the dado is $\frac{1}{4}$ in., I start with a saw setting that will make a tongue slightly

Dado is slightly more than $\frac{1}{2}$ in. from edge of panel. Figure the distance from the edge of the panel to the dado with a piece of $\frac{3}{4}$ -in. plywood. Move the fence until the dado blade just pokes out beyond the plywood.

Pass the panel through on edge to cut a tongue. Cut the tongues in the bottom panel and in the top frame with a dado blade set slightly lower than it was for dadoing side panels. This blade setting cuts a tongue that fits into the dado with a little clearance at the bottom of the dado for glue runout. Set up the saw fence so that the tongue is too fat, then pare it down with subsequent passes until the tongue just slips into the dado.



larger. I pass a panel through on edge (see the top photo at left), then keep reducing this setting to pare down the tongue until it just slips into the dado. Before assembling the cases, I sand the panels. I take it easy when sanding the tongues to prevent changing the fit of the joint.

Use the Back Panel to Square the Cabinet

I assemble the case with glue. When the pieces are aligned, I shoot in one pin to hold them in position and then add four 1 $\frac{5}{8}$ -in. drywall screws to pull the side tight. The screws act as clamps. While the glue is still wet, I square the case by using one square corner of the back panel as a guide. I rack the case flush with the square corner of the back panel and pin it along both sides. Then I drive in some screws to hold the panel permanently and turn the case face up to apply the edging.

Edge the Exposed Plywood

The exposed edges of plywood cases are ugly. Beautifying these edges is a matter of applying hardwood edging. I rip $\frac{1}{4}$ -in.-thick edging from straight-grained, flat 1-in. stock. The side panels are edged first. I cut the edging to length, spread glue on both the plywood edge and the edging, and then pin it in place with an air-driven pinner. Then I cut the crosspieces slightly long and flex them into place (see the bottom photo at left). On narrow cases, I use a press fit because short pieces are too stiff to flex.

To trim the overhanging edging flush with the $\frac{3}{4}$ -in. plywood, I use a router with a trimming bit (see the photo on the facing page). Making several passes from right to left helps avoid splitting. The trimmer leaves a slightly proud edge that I take down with a sander or a plane. With a chisel I square the rounded corners left by the trimmer. After



Hardwood edging covers the exposed plies on the front of the case. Traditional cabinets would have a face frame, but the cases featured here are frameless. Although full-overlay doors cover the cases when closed, opening doors reveals the edges of the case, so edging is required.

trimming, I use a belt sander to make all surfaces flush; then I use an orbital sander with 80-grit paper to round sharp corners. Eased corners make cases more comfortable to handle. Then I fill nail holes and sand all exposed surfaces with 120-grit paper.

Drawers Are Built Like Small Cases

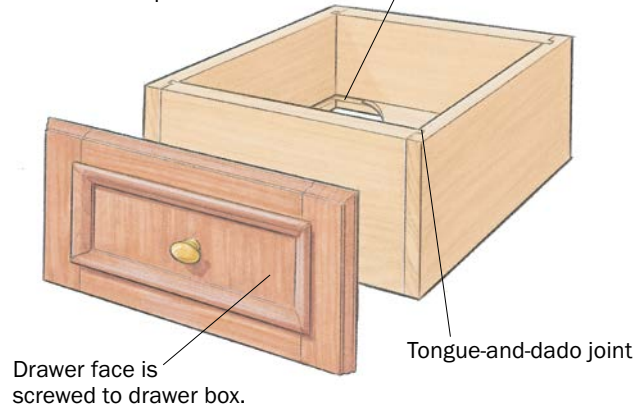
When making a drawer, I think of it as a minicase with $\frac{5}{8}$ -in.-thick hardwood front, back and sides. When cutting drawer stock to length, I take into consideration clearance for the drawer slides; clearances vary depending on the type of drawer slides you use.

Although a dovetail is the ideal joint for a drawer, it's time-consuming to cut. As an alternative, I use the same tongue-and-dado joint that I used in the cabinet. The sides of the drawer are dadoed, and tongues in the front and the back panels fit into the dadoes (see the drawing above). I use a regular saw-

Simple Drawer Construction

Instead of dovetails, the drawer's front and back panels have tongues that fit into dadoes in the drawer's side panels.

Groove inside of drawer box to house bottom panel.



blade in place of the dado to make the dado, and then I make multiple passes with the regular blade to cut the tongues.

I also cut a groove close to the bottom edge of the stock. The groove houses the $\frac{1}{4}$ -in. plywood drawer bottom. Glued in place, the bottom adds to the strength of the drawer and holds it square. I measure the diagonals and rack the drawer square. If a drawer won't stay square, I clamp it to pull or push it into square. Drawer faces are made like shortened door frames, and I screw the faces to the drawers after they're mounted in the cabinet. I close the drawer and clamp the drawer face to it. When the face is positioned, I reach through the top frame and drive a few screws through the drawer and into the face after I drill pilot holes. I check screws' lengths to be sure they won't punch through the face.

Paul Levine of Sherman, Connecticut, is a cabinetmaker and the author of Making Kitchen Cabinets (The Taunton Press, 1988).



Here, edging is trimmed on the case's top frame. After the edging is glued and nailed in place, the overhanging edges are trimmed with a trimmer bit in a router. Edging tears out easily, so the first few passes should run right to left; the final pass runs left to right.

Traditional Cabinetry From a Modern Material

■ JAY GOLDMAN



A year after I installed a fireplace surround that included large, solid-wood raised panels, I was called back to replace a frame that had blown apart when its panel expanded in summer humidity.

When I made the surround, I had left room for the poplar panels to expand. But there wasn't enough expansion space for the largest panel, measuring about 3 ft. by 6 ft. It was too late in the game to change the surround's design, so I made a replacement panel out of medium-density fiberboard (MDF), which is far more dimensionally stable than solid wood. Since then, the job has been problem-free.

After that callback, I decided to change my production methods to develop an efficient system for making paint-grade raised-panel cabinets from MDF that are less susceptible to changes in humidity and temperature than solid wood. I've now used the system on several cabinet jobs with fine results (see the photo on the facing page).

By milling one-piece face frames and frame-and-panel components out of MDF, I can save the considerable labor required for traditional stile-and-rail joinery. In some cases, I use the same piece of MDF both for the frame and for the raised panel. The cut-out, or offcut, from the frame becomes the blank for the panel.

As the price of solid wood increases and high-quality stock becomes scarce, man-made alternatives such as MDF are becoming more attractive. As long as the project is to be painted, MDF has several advantages over solid wood. MDF is generally cheaper, always available, and perfectly flat.

Dimensional stability is just one reason why MDF is ideal for raised panels. Because the material is manufactured in 4-ft. by 8-ft.

High-quality appearance from a man-made material. Most of the components that make up this cabinet, including the raised panels for the doors, drawers, countertop, and cabinet sides, were made from MDF. Once painted, the material is difficult to distinguish from solid wood.

sheets, it can be used to make large panels that don't have to be glued up from separate boards. It also mills cleanly. With no grain, there is little or no tearout.

Face Frames from One Sheet of MDF

The first step in making the cabinet face frames is cutting the MDF to the overall outside dimension of the frame. Then I mark the outline of the stiles and rails in pencil. I cut these lines with a small circular saw, finishing up the corners with a jigsaw.

The edges of the face frames have to be clean and smooth because they will be clearly visible when the cabinet door is opened. I clean these edges up with a router and a bearing-guided, flush-cutting bit. The bearing on the bit rides against straightedges that I tack to the face of the face frame. The rounded inside corners produced by the router bit can be squared off with a file. Once the first face frame has been completed, it can be used as a template for other cabinets of the same size.

Two Ways to Make a Frame and Panel

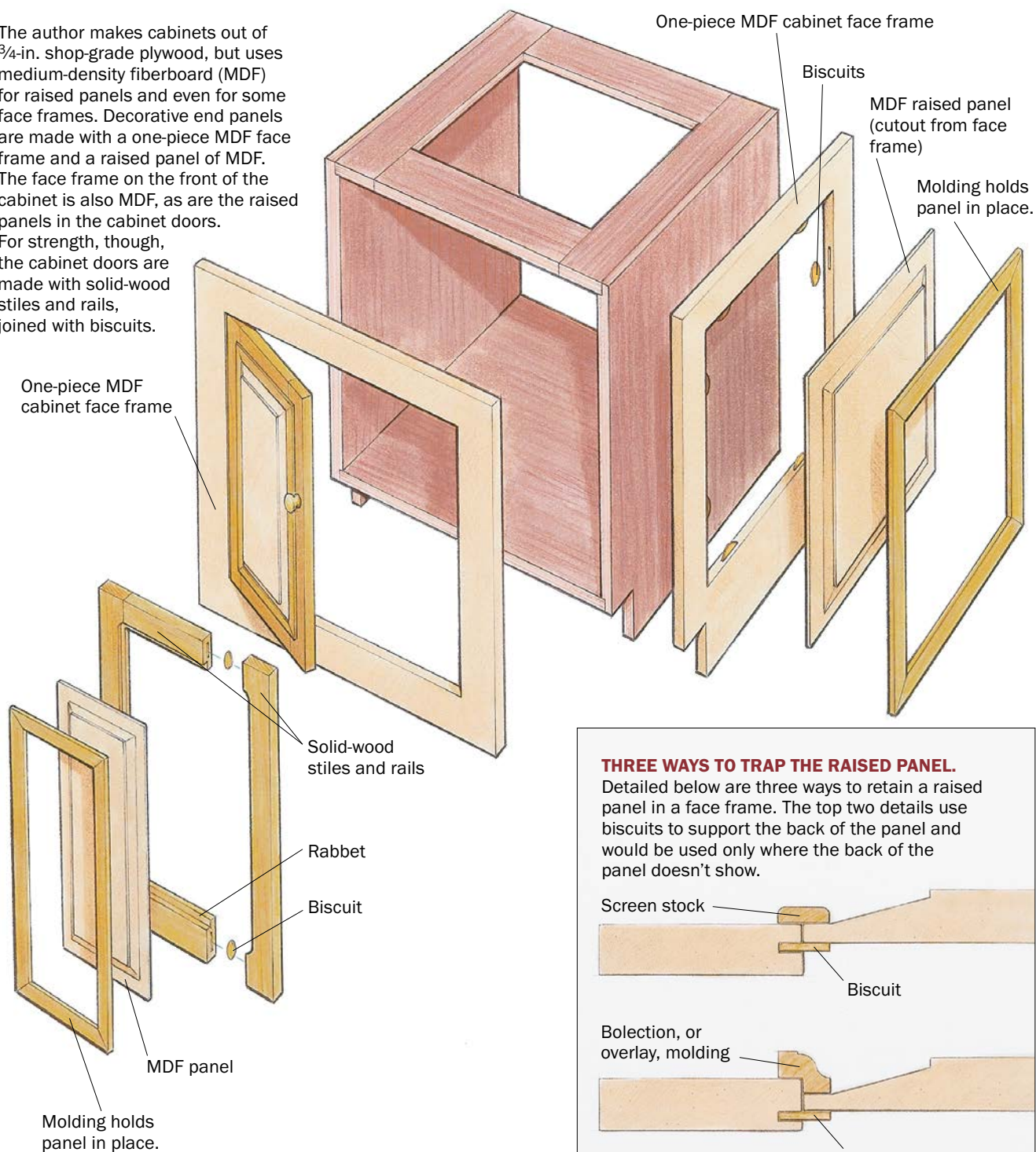
I make frame-and-raised-panel assemblies in one of two ways, depending on how they will be used (see the drawing on p. 48). If the assembly is for the end panel, or return, on a run of cabinets, I make the raised panel and the surrounding stiles and rails all from MDF. If the frame-and-panel assembly will be used as a door, then I make the raised panel from MDF and the stiles and rails from solid wood.

It's possible and cost-effective to make one-piece doors by routing details into a solid sheet of MDF (see the sidebar on p. 50). But if I'm going to the trouble of making a true frame-and-panel door, I make the stiles and rails out of solid wood, which is stronger.

As the price of solid wood increases and high-quality stock becomes scarce, man-made alternatives such as MDF are becoming more attractive.

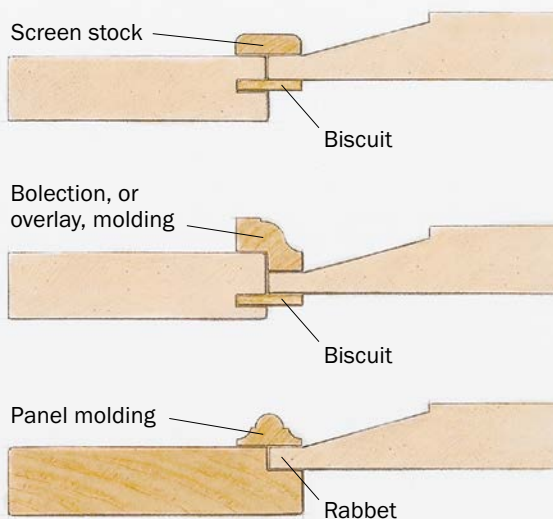
Strategic Uses for MDF

The author makes cabinets out of $\frac{3}{4}$ -in. shop-grade plywood, but uses medium-density fiberboard (MDF) for raised panels and even for some face frames. Decorative end panels are made with a one-piece MDF face frame and a raised panel of MDF. The face frame on the front of the cabinet is also MDF, as are the raised panels in the cabinet doors. For strength, though, the cabinet doors are made with solid-wood stiles and rails, joined with biscuits.



THREE WAYS TO TRAP THE RAISED PANEL.

Detailed below are three ways to retain a raised panel in a face frame. The top two details use biscuits to support the back of the panel and would be used only where the back of the panel doesn't show.





One-piece face frame cut from MDF. To create a decorative end panel, the author makes a face frame by cutting a rectangle from a piece of medium-density fiberboard.

When the plans call for a frame-and-panel return on the side of a cabinet, I build the cabinet box first and then overlay the sides with the panel detailing. This may sound like extra work, but I find it much easier than building a raised panel into the side of the cabinet itself.

I make a stile and rail to go around a raised panel the same way I make a cabinet face frame. I cut the stiles and rails out of a solid sheet of MDF with a circular saw and a jigsaw (see the photo above).

In the case of the side panels, these saw-cuts do not have to be perfectly smooth because the edges will be covered by molding that will bridge the gap between the face frame and the panel. Also, the frame-and-panel assembly will not be visible from the back. The assembly can be nailed, screwed, or biscuited and glued to the side of the cabinet carcass.

Raised Panels Are Trapped Between Biscuits and Molding

To mill raised panels for cabinet sides or for doors, I use a Williams & Hussey molder/planer, which is like a thickness planer and a shaper combined in one machine (Williams & Hussey Machine Co. Inc., P. O. Box 1149, Wilton, N. H. 03086; 800-258-1380). The panels also could be milled with an ordinary shaper or router table.



Biscuits act as stops for raised panel. The raised panel will be supported by biscuits inserted in the edge of the face frame. The biscuits hold the field of the panel proud of the frame.

Remember that it's safer to run large-diameter panel-raising bits at a lower rpm than smaller bits. On a large umbrella-shaped bit, the outside edges spin faster than the edges closer to the shaft. If your router does not have built-in speed control, you can buy a variable-speed switch from a woodworking-supply house. Also, make sure you have bulletproof dust collection because the dust produced from milling MDF is not to be believed.

On the sides of cabinets, raised panels are held proud of the face frame by biscuits glued into slots along the inside edge of the frame (see the photo above and top of p. 51). The panel is trapped in the frame by the biscuits at the back and by bolection, or

A Solid-MDF Door

Making raised-panel doors out of a solid piece of MDF can save labor and materials. Basically, a groove and then details such as beads, coves, and shoulders are routed into the face of the MDF sheet. For the effect to be convincing, the milling operation has to leave the simulated raised panel and frame with square or nearly square inside corners. Also, the cuts in the face of the sheet have to be made with more than one routing operation. If only one pass is made, then the details to the left and right of the groove between frame and panel will be the same.

I've made solid-MDF doors by tacking straightedges on all four sides of a blank MDF panel and then performing three different routing operations on the panel.

The first operation, done with a $\frac{3}{4}$ -in.-dia. straight bit, hogs out a $\frac{3}{8}$ -in.-deep groove in the face of the panel (see the photo below). The next bit mills a cove on the inside edge of the groove. Finally, a $\frac{1}{4}$ -in.-dia. bit cleans up the outside edge of the main groove. This small bit nearly squares off the corners of the main groove (see the photo above).

For all three operations, straightedges are left in the same place around the frame. The path of the router bits is varied with different-size bases on separate routers.

I used to have trouble with sawdust collecting inside the straightedge frame. Part of the problem was that I was using square router bases. They are quicker to make than round ones, and also more likely to be thrown off course by accumulated sawdust. I also improved my dust-collection system. Now I use this method exclusively to make doors with a painted finish. The resulting door has a heavy feel to it, paints well, and is stable.



Sandpaper smooths the routed profile. The groove in the door has nearly square corners made with a $\frac{1}{4}$ -in.-dia. flush-cutting router bit.



Routers turn MDF into cabinet door. Straightedge boards hold the panel in place and serve as guides for the routers.

overlay, molding at the front (see the second photo from the top at right). If the edge of the panel and the face of the face frame are in different planes, then bolection molding, which is rabbeted in the back, will have to be used. Flat molding, such as screen stock, can be used if the edge of the panel and the face of the frame are in the same plane.

Because the raised side panels will be visible only from the outside, the backs of the panels do not have to be of finished quality. In fact, the panel looks quite rough from the back, with its visible biscuits and its jigsaw cuts (see the third photo from the top at right).

The end result (see the bottom photo at right) is almost impossible to tell from a traditional solid-wood raised panel and frame. A painting trick can be used to enhance this look. If the cabinets are painted with a brush, the brush strokes can be placed on the face frame to mimic the grain of solid wood.

Cabinet Doors Combine Solid Wood and MDF

For the cabinet doors, I build solid-wood stiles and rails to accept a raised MDF panel. The frame is joined with biscuits and then rabbeted to accept the panel. The panel is held in place with bolection molding. The frame-and-panel method that I use for cabinet side panels is not suitable for doors because the doors have to be of finished quality on both inside and outside faces.

Because drawer-front frames are small, I usually make them from a solid piece of MDF. Like the door panels in the sidebar on the facing page, the profiles for the drawer fronts are milled with a router.

Jay Goldman is a designer and cabinetmaker in Roosevelt, New Jersey.



Cutout from the face frame becomes the raised panel. The author used a combination molder/planer to raise the panel. It will be held in place by moldings nailed into the face frame.



Pine trim covers the gap between the frame and the panel. The cabinet's panel is trapped between the trim on the front and the biscuits on the back.



The back doesn't have to be pretty. This frame-and-panel assembly will be attached to the side of a cabinet, so its unfinished appearance on the back will be hidden.



Applied end panel is easier. Rather than integrate the MDF frame and panel into the cabinet construction, the author builds a plywood carcass and screws the MDF frame and panel to it.

Hybrid Cabinet Construction

■ JIM TOLPIN



Country metric. Through the adroit use of applied moldings, frame-and-panel doors, and beaded plywood panels, the author produced 32mm cabinets with a country-American flavor.

By now, most Americans know what a typical European kitchen looks like: unadorned, monochrome surfaces separated by crisp joint lines. Besides the streamlined appearance, European-style cabinets are also noted for their accessibility and ease of cleaning. Nevertheless, the June 1990 issue of *CabinetMaker* magazine (Delta Communications, 400 N. Michigan Ave., Chicago, Ill. 60611; 312-222-2000) reported that the market share of these cabinets had dwindled to 15 percent, a 60 percent drop from the previous year.

To a woodworker like me who has made his best money building European-style kitchen cabinets, this was troubling news. I've found these cabinets to be incredibly cost effective to build, even in my one-man shop. They have no face frames to build and install; no complex case joints to execute; and no surface-mounted, nonadjustable hinges or sloppy drawer slides to fight with. Instead, modular cases, prefitted with hardware, are assembled quickly and easily using removable fasteners. The hardware, designed specifically for the European 32mm system of cabinetmaking, not only offers ease of installation, but also allows the fit of doors and drawers to be fine-tuned without requiring components to be removed and rehung.

When Mark and Martha Ditchfield asked me to build them a "country" kitchen to complete their kitchen remodel, I decided it was time to apply the 32mm system to the creation of traditional, "American-style" cabinets. This would allow me to use all the nifty specialty tools and jigs (not to mention the know-how) that I had acquired over the past few years. The challenge would be to create the look of face-frame cabinets with applied moldings and end panels that would work with the 32mm system.

Design by Mail

In preparation for new cabinets, the Ditchfields had gutted their old kitchen and pantry. I drafted two copies of the kitchen's

floor plan at a scale of 1 in. to 1 ft., then sketched a plan view of the upper cabinets on one copy and of the base cabinets on the other. I located the stove, refrigerator, dishwasher, and pantry first, then filled in the blanks with cabinets. Not including the pantry unit, lengths of individual carcasses would range from 18 in. for a stack of drawers to 43½ in. for the corner units, well within my tolerances (for ease of construction and handling, I never build cabinets in sections longer than 60 in.).

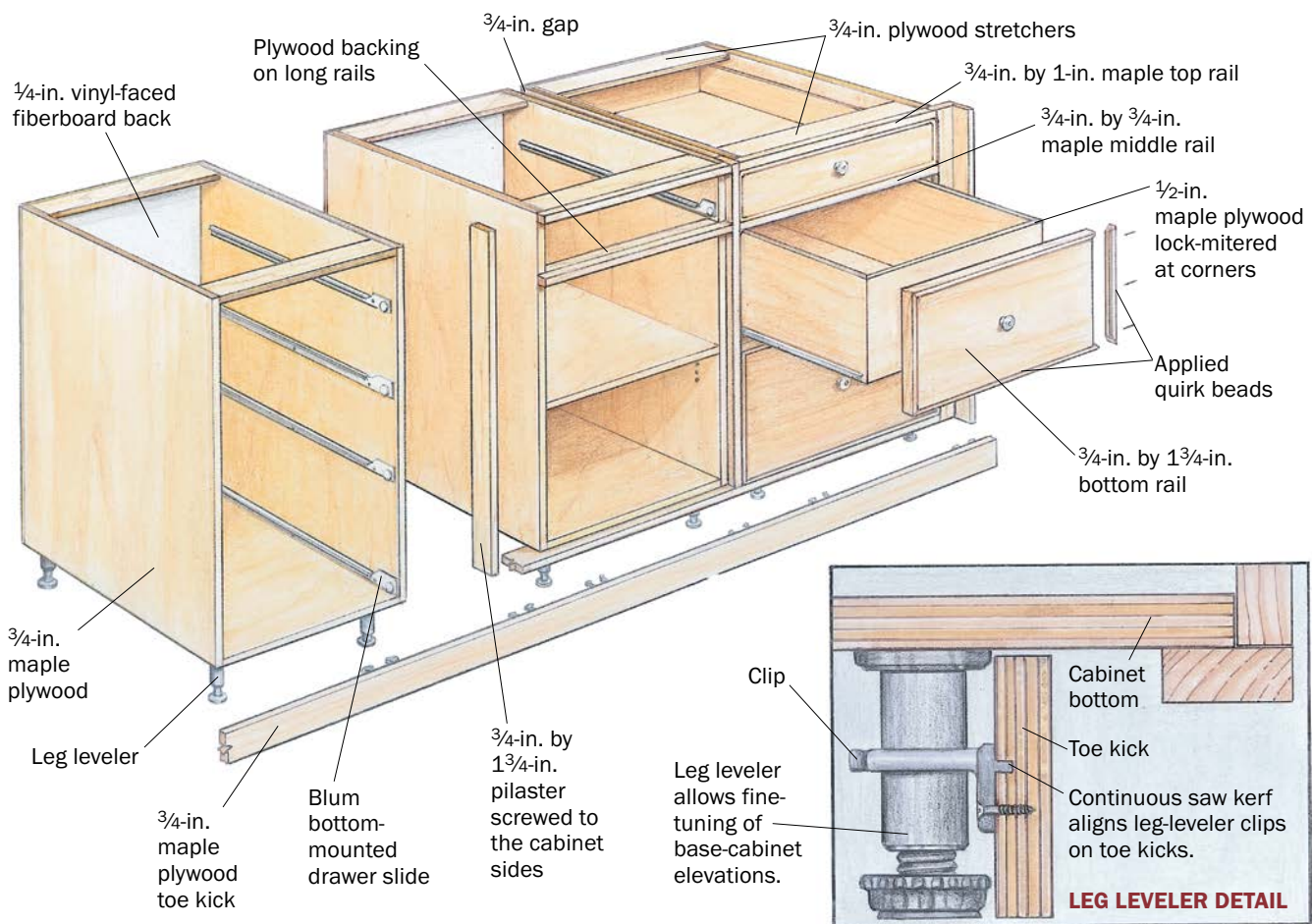
Country-Style Modules

The Ditchfields wanted their cabinets to be built of a light-colored wood with a natural finish, so I chose maple as the primary material, which would be lacquered to allow the grain and color to show through.

Conforming to the 32mm system, the basic carcasses would consist of edgebanded, seven-ply, ¾-in. A-3 maple plywood tops, bottoms, and sides (plywood-top frames for the base units), butt-joined with knockdown (removable) fasteners and backed with ¼-in. white-vinyl faced fiberboard (see the drawing on p. 54). I use knockdown fasteners because they're easier to install, strong enough to eliminate the need for rabbets and dados and are easy to remove should the cabinets need to be dismantled and modified on the job site. Instead of displaying the plastic-laminate surfaces usually associated with 32mm cabinets, the visible sides and backs of the base units would be faced with ¼-in. kadama "Beaded Victoria Panels" (States Industries, P. O. Box 7037, Eugene, Ore. 97401; 503-688-7871). Kadama is an Indonesian hardwood that complements maple in grain and color. Also available in red oak, the panels are commonly used for wainscoting. The exposed ends of the upper cabinets would be faced with plain ¾-in. A-3 maple plywood panels.

I use knockdown fasteners because they're easier to install, strong enough to eliminate the need for rabbets and dados, and are easy to remove should the cabinets need to be dismantled and modified on the job site.

Cabinet Construction



The Ditchfields' cabinets would also feature frame-and-panel doors: solid Eastern hard-maple frames surrounding either 1/4-in. beaded kadama panels or double-strength glass panels embellished with applied lead came (see the sidebar on the facing page). Drawers would have 1/2-in. lauan plywood fronts, backs, and sides fitted with 1/4-in. maple plywood bottoms and solid-maple faces. All door frames and drawer faces would be outlined by an applied quirk bead. An easy-to-install detail, the applied bead would reinforce the kitchen's country appearance.

Typical of 32mm cabinets, the doors and drawer faces would overlay the front edges of the carcasses, concealing the edges when closed. However, instead of butting end-

to-end in the usual manner, the carcasses would be spaced 3/4 in. apart, with the resulting gaps covered by solid maple pilasters. Pilasters would also be installed between the three sets of double doors, next to the appliances and at the inside corners of the cabinets. Finally, horizontal top, bottom, and middle rails would be nailed to the base cabinets, flush with the pilasters.

The resulting facades would give the appearance of doors and drawer faces flush-mounted in conventional face frames (see the photo on p. 52). Applied cornice and pelmut moldings, a tiled countertop, and ceramic pulls would complete the country-American motif.

This hybrid design would allow the use of 32mm-system hardware throughout:

Glass and Lead

Before installing the glass door panels, I applied a grid of a self-adhering, bronze-colored lead strip (Decra-Led®, Ltd., 2601 Portage Road, Portage, Wisc. 53901; 608-742-8386) to the face of each panel to create the illusion of divided lights. This product, which is available in many colors, was installed by peeling a protective strip off the

back to expose an adhesive, then pressing the strip in place with a small rubber roller. I drew reference lines on a piece of cardboard and placed it under the glass to help me align the strips before pressing them in place. Where strips overlapped, I used a small plastic tool (supplied with the lead strip) to mash them together to mimic a solder joint.



Illusions. Applied solid-maple pilasters make the cabinet doors appear as though they're flush mounted in conventional face frames. The "leaded-glass" lights were created by applying a grid of self-adhering, lead strips to each glass door panel.

concealed adjustable door hinges, bottom-mounted drawer slides, 5mm brass shelf clips, and, finally, adjustable legs for the base units covered by removable plywood toe kicks. Amenities would include two space-conserving, half-moon lazy Susans and a countertop appliance garage enclosed by a shop-built tambour door.

Carcase Cutting

Once the Ditchfields approved my plan, the next step was to develop cut lists for all the cabinet parts. I began by listing on a chart all the components specific to each unit. From this chart, it was easy to develop



Drilling jig. Tolpin drilled 5mm holes in the carcase sides for attaching hinge plates, drawer slides, and shelf clips using his portable drill with a special drilling jig.

specific cut lists for the components in each category. Additional charts listed the moldings and applied panels. I used these charts to develop master cut lists. One list specified the total lineal footage of solid stock that would be required in specific widths. A second list of plywood components was converted to graphic illustrations of 4-ft. by 8-ft. panels layed out for optimal yield.

Armed with this information, I started cutting parts out of a forbiddingly tall stack of plywood. I cut most panels on a table saw fitted with an Excalibur rip fence and extension table (Excalibur® Machine and Tool Co.; 800-387-9789). Parts that were too narrow to crosscut safely against the fence (anything less than 14 in. wide) were crosscut on a

radial arm saw equipped with a Biesemeyer® sliding stop (Biesemeyer Mfg. Co., 216 South Alma School Road, Suite #3, Mesa, Ariz. 85210; 800-782-1831), carefully indexed to match the indicator on the table-saw fence. Accurate to within $\frac{1}{64}$ in., the rip fence and sliding stop are easy to adjust and eliminate the need for constant checking with a tape measure.

With the panels cut, I brought all the parts targeted for edgebanding to a production cabinet shop equipped with an expensive, but fast and reliable, edgebanding machine. Edgebanding can be done with a variety of hand-held machines, but I've found them to be excruciatingly slow when working with a large volume of stock. This edgebanding job cost about \$100*.

Drilling the Cases

With the stock edgebanded and back in the shop, I drilled $\frac{3}{8}$ -in. holes in the bottom panels of the base units to receive standard Blum nylon "leg levelers" (Julius Blum®, Inc., Highway 16 Lowesville, Stanley, N. C. 28164; 800-438-6788 or, in North Carolina, 800-222-7551). Next, I drilled a series of 5mm holes in the side panels to provide attachment points for shelf clips, hinge plates, and drawer slides. This operation was accomplished easily with the use of a commercial drilling jig designed specifically for 32mm construction (see the photo at left). Made by J and R Enterprises, Inc. (12629 North Tatum Blvd. #431, Phoenix, Ariz. 85032; 602-953-0178), the jig has two graduated steel fences (one that bears against the top edge of the panel and the other against the bottom edge) linked by two brass-colored aluminum drilling templates that rest on the face of the panel. The templates locate the front and rear rows of holes on the 32mm grid, which is essential when drilling for drawer slides and adjustable shelf clips. This jig, which sells for \$190*, comes

complete with a 5mm brad-point drill bit fitted with an adjustable depth-stop centering collar.

For custom cabinetmakers, there's no need to drill all the holes on the 32mm grid. That's why I use a device called "The Magic Wand" with my drilling jig. It's a 1m long clear plastic scale (marked in inches and millimeters) with 5mm dia. holes on 32mm centers, same as the drilling jig. A variety of plastic inserts snap into these holes to represent hinge plates, drawer slides, shelf clips, and other hardware, which allow me to quickly mock up any hardware configuration. The bad news is that this product (once sold by Blum) is no longer manufactured, although some distributors may still carry it. An alternative is to make pencil marks on the drilling jig itself to indicate locations of the various hardware.

Time to Finish

I cut the solid stock for the door frames, drawer faces, and trim slightly oversized. After jointing the parts to final width, I used a beading bit chucked in a table-mounted router to mold the quirk-bead molding for the doors and drawer faces, then switched to a chamfering bit to shape the edges of rails, pilasters, and pelmut moldings.

After sanding all the cabinet parts with 180-grit sandpaper, I lacquered everything except the drawers and doors, which would be finished after assembly. Interior surfaces received a coat of sanding sealer followed by two coats of gloss lacquer, while exterior surfaces (and later, the doors and drawers) received a coat of sealer plus three coats of semigloss lacquer. I used Hydrocote finishing products throughout (The Hydrocote Co., Inc., E. Brunswick, N. J. 08816; 800-229-4937); they're nontoxic, nonflammable, and fast drying, curing to a clear, durable, water-resistant finish. Each coat was sanded with 220-grit wet/dry sandpaper, and the final coat was buffed with 400-grit wet-dry sandpaper.

Doors and Drawers

Before assembling the carcasses (which would quickly eat up my limited shop space), I tackled the doors and drawers. I cut a groove in each stile and rail to accommodate the kadama panels using a ¼-in. slotting cutter and router table. The grooves stop short of the stile ends, so they don't show at the tops and bottoms of the doors. I assembled the door frames using biscuits and yellow glue, cutting the slots for the biscuits on a stationary biscuit joiner. Because plywood panels are dimensionally stable, I glued the panels into their grooves.

After glue-up, I used a router to round over the door frames around the panel perimeters and to rabbet the back sides of the nine glass-door frames so that the glazing would fit flush with the backs of the frames. Small plastic stops (available from the glass supplier) would later be screwed to the frames to hold the panels in place, allowing easy replacement should a panel break. I scraped and sanded all the frames, tacked on the quirk beads, and rounded over the inside edges of the frames with a router. While I was at it, I also applied quirk beads around the drawer faces.

Next, I drilled holes in the back of each door for a pair of Blum 125-degree clip-on cup hinges. A Blum "Juniorpress" drilling fixture attached to my drill press made it easy to drill simultaneously a 35mm cuphole and two 8mm attachment holes for each hinge (see the photo on p. 58). An attachment on the device allowed me to install the hinges, too. Though the Juniorpress lists for \$600*, I've found it to be a worthwhile investment.

Before assembling the drawers, I routed grooves in the plywood sides and fronts to hold the drawer bottoms, then used a Freud lock-miter bit to cut the corner joints. The drawers were assembled with glue and brads, then fitted with Blum 230 bottom-mounted, self-closing drawer slides, which attach to the bottom edges of drawers for rapid instal-

Use Hydrocote finishing products. They are nontoxic, nonflammable and fast-drying, curing to a clear, durable, water-resistant finish.

lation. Drawer faces were attached with Blum drawer-face adjusters, which are simple plastic inserts I install in the backs of the faces to allow up to $\frac{3}{16}$ in. of adjustment for perfect alignment.

Carcase Assembly

Finally, more than 100 hours into the job, it was time to put together some cabinets. I began by fastening the hinge plates, the drawer slides, and the leg sockets to the appropriate carcase panels, then tacked the carcases together with finish nails, squared them up, and screwed on the fiberboard backs. The side panels were then secured to the tops and bottoms with “Conformat®” threaded-steel knockdown fasteners (Hafele®

Door hinging. A fixture attached to a drill press was used to simultaneously drill a 35mm cup hole and two 8mm attachment holes for each door hinge, as well as to press the hinges into place. Here, the author demonstrates the jig on a sample oak door.



America Co., 3091 Cheyenne Dr., Archdale, N. C. 27263; 800-334-1873). Pilot holes were drilled using a “Zentrix 40 + 50mm” drilling system (also available from Hafele) attached to my electric drill. This fixture, which typically sells for about \$285*, made it easy to drill perpendicular holes the proper distance from the panel edges (see the left photo on the facing page).

Once the carcases were assembled, I flipped them onto their backs and, using a pneumatic finish nailer, installed the pilasters in the double-door openings, all the middle rails and the plywood backing for the cornice moldings. Next, I installed half-moon slide-out shelves in both corner units and a tilt-out sink tray for additional storage. Designed for blind corners (corner spaces that don’t turn the corner), the slide-outs (see the right photo on the facing page) swing out of the cabinet, then slide forward for easy access (Rev-A-Shelf®, Inc., P. O. Box 99585, Jeffersonton, Ky. 40269-0585; 800-626-1126 or, in Kentucky, 502-499-5835). The last step was to install the drawers and the doors.

Installation

To prepare for installation of the cabinets, I snapped level chalklines $34\frac{1}{2}$ in. and $53\frac{1}{2}$ in. up from the high point of the floor around the perimeter of the kitchen to indicate the tops of the base units and the bottoms of the upper units. I established these two elevations using a reservoir-type water level (Price Brothers Tools, 1053 6th St., Novato, Calif. 94945; 415-897-3153), which can be operated by one person.

I installed a corner base unit first by tapping its four adjustable legs into their sockets, sliding the unit into position, and then backing out the legs until the top of the unit was level with the lower chalkline. Next, I fastened a pilaster to either end of the unit with $1\frac{1}{4}$ -in. drywall screws, positioning the pilasters so that their front edges juttied $\frac{3}{4}$ in. beyond the front edge of the cabinet. For each subsequent unit, it was a simple



Knockdown carcasses. Instead of the usual tongue-and-groove joints assembled with glue and conventional fasteners, these carcasses are butt-joined and held together with sturdy, threaded-steel knockdown fasteners. Here, the author demonstrates the drilling of pilot holes for the fasteners using a Hafele “Zentrix” drilling fixture.



Half moons. The two blind corners in the kitchen are fitted with half-moon slide-out shelves. The shelves swing out of the cabinets, then roll forward for easy access.

matter to slide the carcass against the pilasters, level it to the chalklines, and screw it to the pilasters with 2-in. drywall screws. I continued around the kitchen in this way until all the base units were in place and then fastened them all to the wall studs with 2½-in. drywall screws angled through the top frames and into the studs, using shims where necessary to fill the gaps.

The upper units were also fastened to the walls and to each other (through pilasters) with 2½-in. long, #10 oval-head wood screws. End and exposed back panels were attached to the cabinets with 1¼-in. drywall screws driven from inside the cabinets.

Once the cases were installed, I fastened the various horizontal moldings to them with 1¼-in. finish nails. The toe kicks were then cut to length and attached to the leg

levelers with plastic clips hammered into saw kerfs along the backs of the kicks. These clips would allow the owners to remove the kicks to trace plumbing leaks, exterminate pests, or lay a new floor.

Once the shelves were installed, the doors and drawer faces adjusted, and the porcelain pulls screwed on, I filled the visible nail holes with colored putty (Color Putty® Co., Inc., P. O. Box 738, Monroe, Wisc. 53566; 608-325-6033), which can be mixed to the right color, and snapped almond-colored plastic caps (available through cabinet suppliers) over the visible screw heads.

*Note prices are from 1992.

Jim Tolpin is a cabinetmaker and writer in Arcata, California. His books, Building Traditional Cabinets and The Cottage Home are available from The Taunton Press, Inc.

Installing Kitchen Cabinets

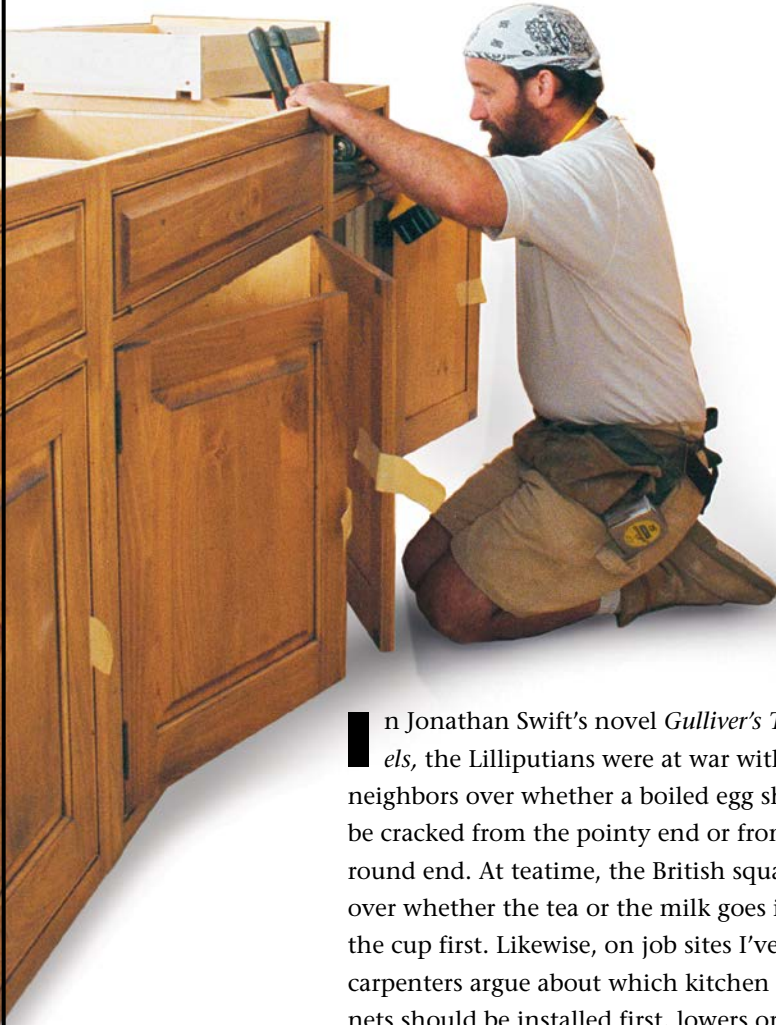
■ KEVIN LUDDY

Check Everything Before Installation Begins

With this kitchen, I received an information packet from the designer. This packet included the floor plan and elevations that showed backsplash and crown-molding heights, as well as countertop dimensions and the specs of the four built-in appliances.

All this information helps me to bid the job accurately, but I also use it during installation. My first task at the site was to check the stock numbers of the cabinets against the floor plan to make sure the order was complete and correct. I also looked at the cabinets for any obvious damage and arranged them in order of installation and by area (e.g., the island cabinets all together).

Next I measured everything in the kitchen, checking my measurements against the floor plans and elevations. I checked wall heights and lengths, locations of lights and outlets, and window and door locations; I also checked the walls for plumb and straight. The only major problem I found in my investigation was an out-of-place outlet, and lucky for me, an electrician was on site that day.

A carpenter with a beard, wearing a white t-shirt, a patterned bandana, and a tool belt, is kneeling on the floor. He is working on a set of wooden kitchen cabinets, using a screwdriver to adjust a hinge. The cabinets are made of light-colored wood and have a traditional design with raised panel doors. The background is plain white.

■ n Jonathan Swift's novel *Gulliver's Travels*, the Lilliputians were at war with their neighbors over whether a boiled egg should be cracked from the pointy end or from the round end. At teatime, the British squabble over whether the tea or the milk goes into the cup first. Likewise, on job sites I've seen carpenters argue about which kitchen cabinets should be installed first, lowers or uppers. Read on to find out which way I prefer.



The Starting Line.

The floor is first checked for level (1). The cabinet height is measured from the high point, and a level line is drawn. The same height is measured from the low point (2), and a second line is drawn (3) to find the difference and to check the first line. The first base cabinet is set and shimmed to the top line (4).



Two Lines Set the Cabinet Height

After checking the floor for level (see photo 1), I measured up the height of the base cabinets (in this case 34½ in.) from the high spot for each run of cabinets and drew a level line across the wall with a 4-ft. level. A laser level would also work well here. I don't recommend snapping chalklines, though. They're usually too fuzzy and not always level.

Next I found the low spot for each run, measured up the same distance (see photo 2) and drew a second line (see photo 3), which gave me the range of floor error and checked the accuracy of my first line. If the lines are

parallel, I'm all set. If not, I go back and try it again. The finished kitchen floor (½-in. tile over ¾-in. subfloor) had not been installed, so I could count on it to hide shims. (Otherwise, I would have had to undercut, or scribe, the base cabinets, which is time-consuming.) The top line then became my guide for cabinet level.

I then marked the stud locations along the level line. I also located critical points such as the window centerline. Some carpenters mark the location of each cabinet along the level line, but I usually scrunch the exact locations by fractions as I go to make everything fit, which would render those marks wrong.

The Base Cabinets Go in First

Installing base cabinets first takes a little more care, but I use the lowers to help with installing the uppers. Besides, most bad surprises show up when installing the lowers.

For this kitchen, I began with the lazy Susan corner cabinet. I transferred the stud locations to the back of the cabinet and drilled screw holes through the hanging strip for every stud location.

Then I placed the cabinet in the corner, shimmed it plumb and level (see photo 4), and drove a #10 by 2½-in. pan-head screw through each hole. I steer clear of using dry-wall screws when I'm attaching cabinets because they have little shear resistance. Then I laid out and drilled the screw holes

for the cabinet to the left of the corner and slid it into place.

To join the two cabinets, I first clamped the face frames together, lining up the faces and the tops flush. Next I shimmed the cabinet plumb and level, and joined the face frames with screws through predrilled holes. I finished by screwing the cabinet to the wall.

This kitchen had a full-height wall-oven cabinet next in line. To attach the cabinet, I joined the face frames as before (see photo 5) but clamped a framing square to the top of the base cabinet to keep the oven cabinet square to its neighbor (see photo 6). I then plumbed the other side of the oven cabinet (see photo 7) and drove screws top and bottom to hold it in place.



Joining cabinets. Face frames are clamped flush (5) and then screwed together. A framing square clamped to the cabinet (6) keeps tall cabinets square to shorter ones. Tall cabinets are plumbed (7) and then screwed to the wall. Cabinets are kept level while they're being joined (8).



Fridge Cabinet Is Assembled on Site

On the other side of the corner, I leveled and installed a double-drawer base cabinet (see photo 8). The fridge cabinet that came next had to be built on site from factory-supplied parts.

I began by setting the overhead cabinet on its side. Next I positioned one side panel on the overhead cabinet, supporting its loose end on a base cabinet. After lining up the top and front edges, I screwed through the panel and into the cabinet.

After carefully flipping over the unit, I installed the opposite side panel (see photo 9), this time using trim screws. With the unit assembled, I lifted it and rotated it into place (see photo 10). Like most refrigerator cabinets, this one was deeper than the base cabinets. I plumbed and leveled the cabinet and then screwed the left side into the face frame of the adjoining base cabinet.

Holding the unit plumb, I screwed the overhead cabinet into the studs. To stabilize the sides and to keep them at the proper width, I screwed two spreader cleats to the wall, one at the floor and another at the height of the base cabinets (see photo 11). A trim screw anchored the side panel to the cleats. The finish floor will lock the bottoms of the panels firmly in place.

Bevel Cut Makes a Tight Scribe

This kitchen had two other cabinet runs, a freestanding island and cabinets along an outside wall for the kitchen sink, dishwasher, and trash compactor. The kitchen-sink base had to fit over a toe-kick heater and accept an unusual sink, so I assembled it from parts supplied by the cabinet company (see the sidebar on p. 64).

The sink base had a fixed width, so I marked out its dimensions centered on the window. Next I double-checked all the clear-



Building the fridge cabinet. The refrigerator cabinet is made from two side panels joined to a top cabinet (9). The cabinet is carefully positioned (10) and attached to its neighbor. Wall cleats hold the sides at the proper width (11).



ance specs and left the correct space on both sides of the sink base for the appliances. On the right side of the dishwasher, I installed a wine-rack end panel screwed to a 2x cleat on the wall.

The cabinet on the other side of the trash compactor had a preattached filler piece that had to be scribed to make the cabinet fit properly. To mark the scribe, I first set the cabinet in place and shimmed it level

A Sink Cabinet from Factory-Supplied Parts

While writing a song, a friend once asked me how many Ps there were in “obstacle,” as though it rhymed with Popsicle®. Of course, there are no Ps in “obstacle,” but there were many obstacles to using a stock cabinet at the sink location in this kitchen project.

In addition to the plumbing pipes, it was to receive a specialty sink, and it sat over a toe-kick heater vent. With all these variables, the designers opted to build the cabinet on site from factory-supplied parts.

I started by building the toe kick of 2x stock ripped to a height that would fit the vent cover supplied to me. It was slightly taller than the standard toe kick, but the difference would be seen only by the bristles on the kitchen broom. With the appropriate gap left for the vent, I squared and leveled the base, centered it under the window, and glued and screwed it to the floor (see top photo).

The base platform went on next, followed by the sides (see center photo). I cut the lower front corners of the side pieces to match the toe kick on the rest of the kitchen. A 1x wall cleat anchored the sides in back.

Building the sink base from parts meant not having to drill holes for the plumbing, but when drilling is necessary, I measure the vertical location from my level line on the wall. I take the horizontal location from the adjacent cabinet and transfer this information to the back of the sink base, remembering to subtract for any face-frame overhangs. Next, I bore halfway through from the backside and then finish the hole from the inside.

The final step was installing the finished front, which was glued and tacked to the sides (see bottom photo). It looked a little funny when I was done, but I knew that with the countertop, sink, and appliances in place, you’d never be able to tell that the cabinet was built on site.





Scribing an attached filler. Cabinets with attached fillers have to be scribed to fit. With the cabinet in place, the cut is traced onto the filler (12). Next, the cut is made with the saw tipped to create a bevel (13), which lets the cabinet fit tight against the wall (14).

Blocks Anchor the Island in Place

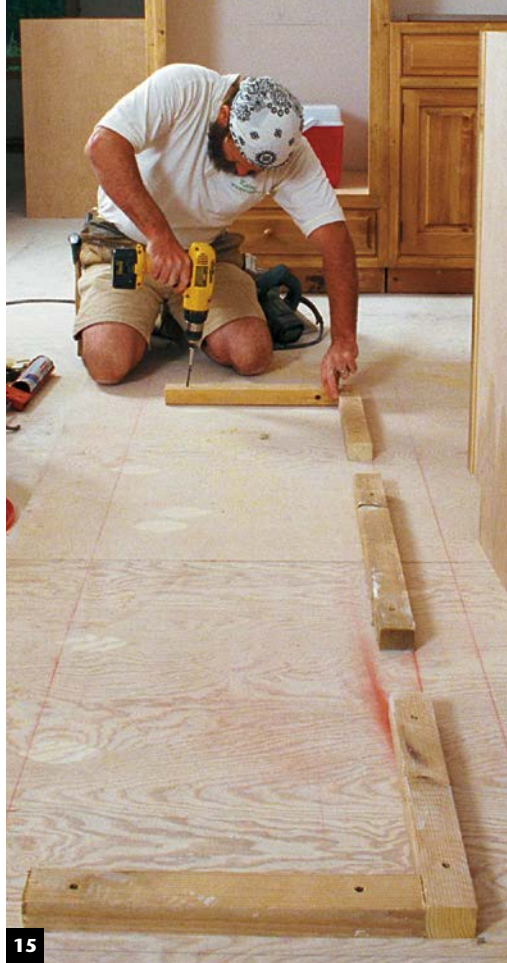
Islands and peninsulas are special situations because the cabinets don't attach to walls. For this island, I began by snapping chalklines on the floor, laying out the full perimeter of the island.

One side of this island had a standard toe kick, but the other side was to be covered with a solid beadboard panel. On the toe-kick side, I subtracted the toe-kick depth and the thickness of the cabinet wall and snapped a second line. I also marked where the cabinets were joined together. I then glued and screwed 2x blocks to the floor at the ends of the island and along the toe kick, leaving plenty of space where the cabinets would be joined (see photo 15 on p. 66).

Next I ran a bead of construction adhesive on the blocks where they would contact the cabinets and then slipped the

and plumb. Then I set my compass scribes and marked the cut on the filler piece (see photo 12).

I try to put a slight bevel on all my scribe cuts, so I tipped the saw table slightly as I followed the line (see photo 13). Masking tape on the bottom of the saw helps to protect the cabinet. The bevel cut lets the cabinet fit more tightly against the wall (see photo 14). If the cut needs fine-tuning, I do it with an electric grinder. When I was happy with the fit, I screwed the cabinet into place. Note that with a wider filler piece, a wall cleat may be needed for attachment.



Assembling the island.

After chalklines are snapped for the island, 2x blocks are glued and screwed inside the perimeter (15). The cabinets are then glued to the blocks and joined front and back (16). Screws driven into the blocks from the front (17) will be hidden by the toe kick. A finished panel is then glued and screwed to the cabinet backs (18).

cabinets over the blocks. The cabinets were then clamped and screwed together in the front and back (see photo 16), keeping the whole assembly level and square. I screwed the cabinets to the blocks along the toe kick (see photo 17) where the screws would be hidden and drove the trim screws through the end panels to hold them in place until the glue cured. The beadboard panel went on next (see photo 18), and the island was solid as a rock.

Upper Cabinets Ride Piggyback on the Bases

With all the lower cabinets in place, the final step before moving to the upper cabinets was installing countertop support cleats as needed. The first upper cabinet I set in was the corner unit that was to rest on the countertop. I blocked the corner unit to the

thickness of the countertop and made sure that it was absolutely plumb and level. I also checked the distance to the other cabinets. The corner cabinet was left loose so that I could slide it up and out of the way when the countertop was installed and then drop it down for a precise fit on the granite counter.

For this kitchen, the refrigerator cabinet and the oven cabinet set the height of the upper cabinets. I marked the stud locations on the hanging strip of the first upper cabinet and drilled holes through to the inside of the cabinet (see photo 19).

Next I cut two 2x riser blocks to the exact distance between the upper cabinets and lower cabinets. I screwed the blocks to the wall where the screw holes would be hidden by the backsplash (see photo 20), which let the base cabinets take the weight and set the level. I then placed the predrilled cabinet on the blocks and pushed it into place against the wall.



Upper cabinets get a boost.

Stud locations are marked on the back of the cabinet, and holes are drilled (19). Blocks cut to the distance between the uppers and lowers and screwed to the wall (20) hold and level the cabinet until screws are driven into the predrilled holes (21). After plumbing and shimming are done, extra screws are driven through the hanging strip and through the face frame.

I drove screws through a couple of the holes to hold the cabinet in place temporarily while I checked for plumb and level. Shims were added where needed, and then I drove screws in permanently through all the predrilled holes (see photo 21). I also predrilled and drove in screws along the bottom inside of the cabinet and through the face frames.

I rechecked the corner cabinet for plumb and followed the same installation procedure for the rest of the uppers. At the window, I set the wall cabinet to the right of the window and then scribed the left-hand cabinet so that it fit at the same distance from the window.

Finishing Up

As the upper cabinets go in, I pay extra attention to doors to make sure that plumbing and leveling hasn't caused them to rack. If I do notice a racked door, I try to cheat the cabinet a little to compensate, or I fine-tune the

door after all the cabinets are in. I finish off the kitchen by applying the toe kick, crown molding, and knobs.

These kitchen cabinets came with holes for the knobs already drilled. But if this isn't the case, I double-check with the clients for the exact knob locations before mounting the knobs or pulls. I putty all the nail and trim-screw holes, but usually save any touch-up until after the countertops are installed. All doors are given a last check for swing and fit, and I check shelves, drawers, lazy Susans, etc.

I give the room a sweep, which keeps me in the good graces of the clients and contractors and ensures that I've rounded up all my tools. Now we're finished. Let's eat!

Kevin Luddy runs Keltic Woodworking, a custom-carpentry and cabinet-work business in Wellfleet, Massachusetts.

Making Heart-Pine Cabinets

■ DANIEL FOSTER

A fellow I worked with in Vermont some years ago was a third-generation carpenter. “Brad,” his grandfather once said to him, “we weren’t any better carpenters than you. We just got all the good wood.” Almost ten years after Brad told me that story, the words are even more true. Good wood is getting scarce. It was a welcome opportunity then, when I had my first chance to work with wood of grandfather’s day.

My client and I had been discussing the merits of various woods for his kitchen cabinets. He was pushing for pine, which I said was too soft. When I asked what color he wanted, he pointed to a small table and said, “Pumpkin pine.” “Oh, that’s different,” I said. “That’s heart pine.”

Many Salvaged-Wood Dealers Carry Heart Pine

Longleaf pine, also called heart pine, is one of 11 species of southern yellow pine. The recycled wood available now was harvested from frames and floors of buildings built

in the past century. The trees from which this wood came grew slowly, in part because of the competitive nature of virgin forests. Mature trees often were up to 300 years old. In the wood I purchased for this kitchen, it was not hard to find over 30 growth rings to the inch. Longleaf pine still is found in forests in the Southeast, but most old-growth trees were cut in the 1700s and 1800s.

Heart pine is far denser than any other cabinet-grade pine and is available in several grades, from knotty to perfectly clear. Because it’s from dense, old-growth stock, the wood used for these cabinets should be more stable and more likely to wear well. Its durability is enhanced by the way it was milled. Most of the recycled timbers were quartersawn, which results in a greater percentage of boards with vertical grain.

Antique heart pine’s working characteristics include stability, high density or hardness (for a softwood), high resin content, and a tendency for brittleness. It’s a great source of splinters.

When I purchase wood for cabinets or for furniture, I usually make it a point to select boards by hand. In this case, I ordered the



wood sight unseen from Mountain Lumber (P. O. Box 289, Ruckersville, Va. 22968; 800-445-2671). The supplier had assured me of the wood's quality. At nearly \$8* per board foot, I expected the wood to be good, and I wasn't disappointed.

Easy to Cut, Harder to Shape

I had little difficulty cutting or planing heart pine. I received the stock in rough form and ran it through a planer with little tearout. The boards were so straight hardly any truing was required prior to ripping, and I used the joiner hardly at all. I have a high-quality Forrest combination blade (Forrest Manufacturing Co., 461 River Road, Clifton, N. J.

07014; 800-733-7111) on my table saw with a stabilizer, a flat metal disk installed alongside the blade to reduce vibration. This combination produced cuts ready for glue-up.

Routing, though, required more attention. For the raised-panel cabinet doors (see the photo above) I made on a router table, I used matched rail-and-stile cutters and a vertical panel-raising bit. At this point I found that the wood had a strong tendency for tearing out and splintering. This problem was especially bad with smaller-diameter cutters, such as the one I used to make the small astragal molding that covers the joints between cabinet face frames and side panels. Until I made a zero-clearance fence for this profile, I was getting terrible tearout every few feet.

An old material lends a sense of warmth to a new kitchen. The longleaf pine used to make these cabinets, commonly called heart pine, originally was cut from old-growth forests in the South and the Southeast. The wood was salvaged from old buildings and was remilled.



Keep the router bit from biting off too much material. The author made a zero-clearance fence from MDF for router bits used to fabricate the face frames and raised-panel doors. The MDF fence was carefully swung into the spinning cutter until the fence was in line with the bit's guide bearing. Very little tearout occurred as the workpiece was fed through the router table because there was no gap between the cutting edges of the bit and the fence.

A Shop-Made Fence Reduces Tearout

The zero-clearance fence is simply a piece of smooth medium-density fiberboard (MDF) attached to the router-table fence and then moved into the rotating cutter until the fence and cutter are positioned for use (see the photo above). With some router bits, I cut away some of the MDF with a jigsaw

first to allow the bearing to clear. This fence eliminated nearly all of the tearout.

I used a similar fence with most of the router bits, including the vertical-panel raiser, the bead-forming bit, and the rail-and-stile sticking cutter (the half of the two-piece set that cuts the profile along the long edges of the rails and stiles). Only the rail-and-stile coping cutter didn't need one; it only cuts end grain. A piece of scrap used for backup eliminated tearout in this case.



First, rough out the raised panels on the table saw. The author fabricated the raised panels in three steps. First, he defined the outline of the raised panel with a table saw by cutting a shallow kerf in the panel's face. Then, still using the table saw, he removed most of the stock from the shoulder of the panel.

In making raised panels, it is relatively common practice to remove some of the stock from the shoulder of the panel with a table saw before running the panel through the router table. This technique was particularly useful with heart pine, again reducing tearout (see the photos above).

High Resin Content Slows Sanding

Because of the high resin content of the wood, sandpaper clogged quickly. A belt sander can be cleaned with a crepe-rubber cleaning stick, but orbital sanders are a different story. The only solution there seemed to be to change paper fairly regularly. The use of stearate-coated paper (stearates are anticlogging “lubricants”) helped, but not a

lot. Some boards contain higher than average resin content. They literally are heavy with clear, hard resin, and they clog paper especially badly. On these boards, I found a scraper to be more effective at removing resin. Although heavy resin makes the wood hard to work with, I find it beautiful. The resin creates a stunning dimension of depth.

I thought the high resin content of the wood might create difficulties in gluing, but it did not. My wood supplier recommended ordinary yellow carpenter's glue, and it worked well.

The relatively brittle nature of heart pine means that nearly invisible cracks parallel to the growth rings can exist in the wood. If the wood isn't carefully examined, cracks can go unnoticed until you're preparing to put on finish.



Then run the panel by the panel-raising bit. Each panel was milled to its final shape with multiple passes along a router table and vertical panel-raising bit. The tall fence helped the author keep the panel vertical.

You Can Biscuit-Join Narrow Face Frames

I am a believer in biscuit joiners. In my opinion, a biscuit joiner is to cabinetmaking what a nail gun is to carpentry. I wouldn't want to do either job without the appropriate tool. Both the birch-plywood carcases and the face frames were joined with biscuits. My assistant and I used three biscuits in each joint of the wall cabinets and six in each joint of the wider base cabinets.

Our techniques for joining the face frames were a little unusual. Although many of these members are only 1½ in. wide, we used #20 biscuits, which are more than 2 in. wide, to join them. I prefer the larger biscuits because they reach deeper into the boards being joined, thus providing considerably more gluing area. I used a bandsaw to cut off as much as ½ in. from each end of the biscuits, reducing them to just less than 1½ in. long. Lamello® (Colonial Saw Co., 845 Milliken Ave., Suite F, Ontario, Calif. 91761; 800-252-6355) makes a small, round biscuit that would have worked within these parameters, but these biscuits have to be ordered from a Lamello dealer and require cutting round slots on a router table. In general I prefer to use a standard biscuit joiner.

Bead hides the biscuit slot.

The cabinets' face frames appear to have been made of beaded stiles and rails. In fact, the bead was installed after the frames were assembled. The decorative bead covers the exposed biscuits that result when biscuit-joining narrow rails and stiles. Joints between face frames and raised side panels were covered with astragal molding.



One result of this approach is that the slots cut into the stiles and rails for the large biscuits are visible at the inside edge of the finished face frame. We covered these slots with narrow beaded trim that wraps around the inside of every opening (see the photo below). The visual effect of these face frames with the inner bead is much like that of beaded rails and stiles. I find this technique to be much easier, and the speed and strength of biscuits is a big plus.

When attaching the bead to the face frames, I allowed it to extend slightly beyond the face of the rails and stiles. This approach did two things: It provided a greater level of depth to the cabinet detail, and it broke up the plane that otherwise would have extended uninterrupted across the face frames and inset doors. We also were allowed a margin of error in case a door was not exactly flat or perfectly hung. Inset doors are fussy enough; I like to have this slight assistance.

The face frames were glued, clamped, and face-nailed to the carcases. The astragal molding that conceals the joint between cabinets covered most of the nail holes in the face frames. To hide the brads holding the astragal, we used a mixture of shellac and fine heart-pine sawdust as filler. The resulting color closely matched the tone of the finished cabinetry.

A Better Grain Match Is Possible with Custom-Made Doors

Some people think I'm crazy to make doors and drawer fronts when they can be purchased inexpensively. That argument is good for paint-grade work. But for me, it's better to have control over how individual boards are used. There should be a good match in the grain on a series of drawer fronts. On a cabinet with two doors, those doors should go well together. Until I learn otherwise, I will continue to believe this situation can

be controlled only if I make these components myself.

The drawer boxes, also of heart pine, were assembled with machine-cut, through dovetails (see the photo at right). All of the drawers have birch-plywood bottoms and are mounted on full extension slides.

Clear Finish Brings Out the Beauty of Heart Pine

After some experimentation with finishes, I found white, or clear, shellac to be a perfect first coat for heart pine, followed by a nonyellowing, water-based urethane. Despite its name, clear shellac has an amber tone, and it brings out the color in heart pine. Some urethanes contain ultraviolet blockers that keep sunlight from deepening the wood's color. We chose one, Hydrocote Polyurethane (77 Milltown Road, E. Brunswick, N. J. 08816; 800-229-4937), that allows the sun to reach the wood. Heart pine ages gracefully, and I wanted to let it do so.

I experimented with finishes on both the heart pine and the birch cabinet carcasses to make sure that the two would go together well. The two woods clearly differed in color, but I thought they looked good together. The use of clear shellac as a sealer on both the pine and the birch helps give a compatibility in tone and results in a good color match where there are dark heartwood areas in the birch.

Flooring and Trim to Match the Cabinets

We also ordered heart-pine flooring, baseboard, casing, and crown molding for the kitchen from Mountain Lumber. We ordered the flooring in a lesser grade, select prime, that contained some solid knots and a larger percentage of holes from pulled nails and screws. This lower grade adds character, sometimes too much. We found that the



Dovetails display vertical grain. Drawer boxes were made of pine boards joined with through dovetails. The bottoms of the drawers are $\frac{1}{4}$ -in. birch plywood.

need to make decisions on the acceptability or placement of imperfections increased the time it took to lay the recycled material, as compared with conventional strip flooring.

Both the clients and I are pleased with the kitchen. It is warm and relaxing, but at the same time rich in detail. Although many of the details are derived from the look of contemporary English cabinetry, including the beaded openings, complex drawer fronts and astragal moldings, the heart pine makes the kitchen seem unmistakably American.

**Note prices are from 1996.*

Daniel Foster is a cabinetmaker and contractor in Leesburg, Virginia.

Simple Frameless Cabinets Built on Site

■ JOSEPH B. LANZA

I have to admit I was a bit slow to catch on to the advantages of frameless cabinets. I had problems with the edgebanding and the European-style cup hinges that inevitably go along with frameless cabinets. When I first tried the hinges, I found them awkward to use. Setup and layout meant deciphering arcane diagrams with odd, unfamiliar dimensions. The much-touted adjustability of the hinges seemed to require an awful lot of adjusting and readjusting. Frustrated, I concluded that this cabinet-hinge combination was best suited for factory production or, at the very least, a shop dedicated to the 32mm cabinetmaking system that originated in Europe.

But that was quite a few years ago. Now, after a series of improvements to both the hardware and the user, I find myself using these hinges all the time. The clip-style hinge, now made by several manufacturers, is a big improvement over earlier versions. This hinge makes it possible to hang and

remove doors quickly, without tedious readjustment every time. I incorporated these hinges into a hybrid system for building face-frame cabinets with inset doors.

These hinges were so much better, they encouraged me to give frameless cabinets another try. They have a clean look (see the photo on the facing page) that seems especially well suited to a spare architectural style. I looked for a way to build them on site quickly and easily, and the answer was simple: Make cabinet boxes just as I'd been making drawer boxes for years.

Using Baltic-Birch Plywood Eliminates Edgebanding

For the little guy, edgebanding has always been the biggest headache in building frameless cabinets. The commonly available iron-on edgebanding just doesn't cut it for

Simple floor plan, simple cabinets.

Frameless cabinets in Baltic birch are compatible with the contemporary flavor of this small kitchen. Wall cabinets have no backs, and upper cabinets are open shelves.



me, and ripping, applying, trimming, and sanding thin strips of solid stock is a huge pain in the neck. Because I make most of my drawers from 1/2-in. Baltic-birch plywood with tongue-and-groove corner joints, I realized I could make cabinet boxes the same way with 3/4-in. stock. Unlike ordinary hardwood plywood, Baltic birch is all birch with no softwood and no voids in the core. It is made up of thin veneers of alternating grain, which makes for a pleasing striped pattern when the edges are sanded or routed. Edge-banding can be avoided entirely.

As with cup hinges, Baltic birch can take a bit of getting used to. It comes in 5-ft. by 5-ft. sheets, so if you don't have long arms, a plastic panel lift will come in handy. Baltic birch tends to warp if left unused and unbraced, so if it looks as if it has been around the lumberyard for a while, you may want to pick from the middle of the stack. It also is notoriously out of square, so you will want to check for (or make) a straight edge before you rip it. The sheets also tend to vary a bit in thickness. I've never had a problem with sheets from the same lift, but I sometimes run into a mismatch when mixing leftover pieces with a new delivery.

That said, it is great, and I love to work with it. Here in Massachusetts, Baltic birch is stocked in quite a few lumberyards and at nearly all plywood suppliers. Prices for a sheet of 1/2-in. stock are around \$25* and about \$35* for 3/4 in., but you can usually get a substantial price break if you can buy a full lift.

Lay Out Cabinets on a Story Pole, then Cut All the Parts

My first step in building cabinets always is to make a story pole, which is a piece of stock about 2 in. wide and as long as the longest dimension in the kitchen. I lay out everything on the pole. This procedure gives me a chance to make my mistakes at full scale and to check my measurements on site before building the cabinets. I mark all cabinet sides, tops, and bottoms, and joints directly on the sticks. I make a cutlist from the stick, then rip and crosscut all the cabinet parts (see the photo below) on a table saw.

Because there is no face frame to add strength and stiffness to the carcasses, the corner joints have to be solid. There are a

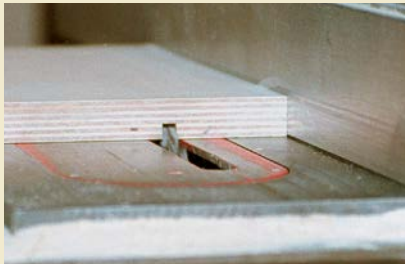
It's safer with a cutoff box.

A table-saw cutoff box ensures that cabinet parts will be square. When working with Baltic birch, don't assume that factory edges are square.



A Simple Joint Makes Strong Cabinets

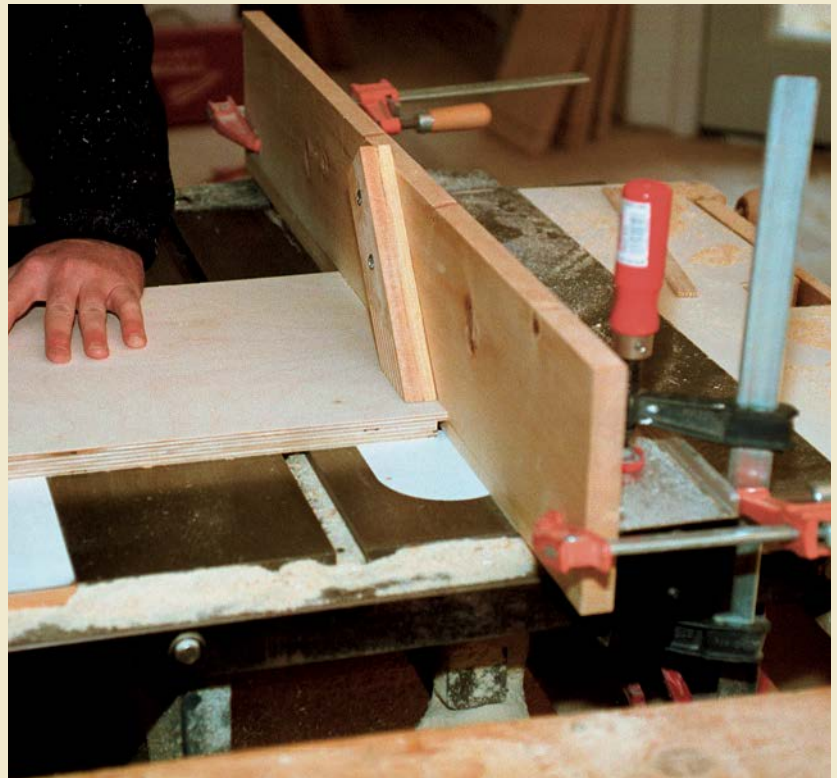
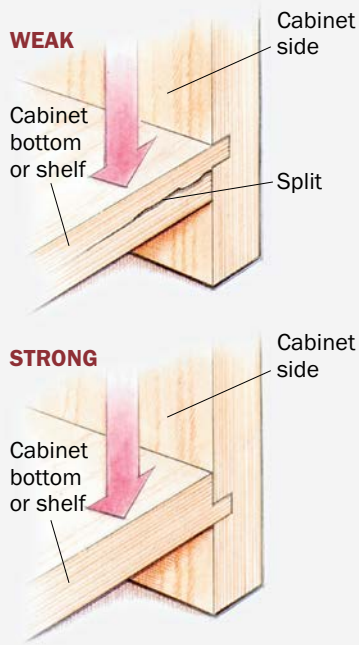
Building cabinets on site calls for a strong joint made with minimal tooling. The author chose the rugged tongue-and-groove joint, made with a table saw.



Leave room for the lights. Grooving cabinet sides 2 in. from their bottoms creates space to hide over-the-counter lights.

STRENGTHENING A TONGUE-AND-GROOVE JOINT

Orienting a cabinet bottom or shelf incorrectly (top) makes a weak joint. The shelf is susceptible to splitting and will behave as if it were the thickness of the tongue. Putting the joint together with the thick part of the shelf facing up (bottom) is the stronger option.



Cutting the tongues. A featherboard attached to an auxiliary fence makes the process safer and the tongues more consistent in thickness.



Nails secure cabinet boxes while the glue dries. Check for square by comparing diagonal measurements before the glue sets.

number of methods that work well—biscuits, screws, knockdown fasteners—but I like the tongue-and-groove joint. It is easy to set up on a table saw with a dado head, quick to cut and easy to assemble, and it gives lots of gluing surface. I make the cabinet sides full length and then cut the grooves in them, being sure to orient the groove so that the joint will have maximum strength (see the drawing on page 77). The cabinet tops and bottoms get the tongues.

The groove is $\frac{1}{4}$ in. wide and a strong $\frac{3}{8}$ in. deep. I set up and cut all the grooves for the base cabinets at the same time. Then I move the fence 2 in. away from the dado head and run the wall cabinet sides, which have a 2-in. gap at top and bottom (see the photo at left on p. 77). These gaps lower the top shelf, allowing the cabinet sides to

rise above it as a curb. This gap also makes room for the bottom rails that conceal the recessed lights.

The dado setup for the tongues is the same for all cabinets, so after I get a good fit on a test piece, I cut all of them (see the top photo on p. 77). To be strong, the joint must fit together snugly. Base cabinets don't have solid tops, just spreaders. To make them, I cut the tongue on a piece of scrap 6 in. to 7 in. wide (it's not critical), then rip that in half. These pieces go at the front and back of the cabinet to hold the sides together and to provide some support for the countertop. The cabinet bottom is, of course, solid. If the cabinets have backs, I cut them next (the cabinets in the photographs don't have backs). I make the cabinet rails from leftover $\frac{3}{4}$ -in. stock.

Light cabinets mean easy installation. After marking stud locations, the author hangs upper cabinets. Without backs and doors, these boxes are light enough for one person to hold in place as they are screwed to wall framing.



Two Steps for Base Cabinets



Set the bases first. To make leveling them easier, the author installs the bases separately from the cabinets. With the bases secured, he then sets the cabinet boxes in place and screws them to the wall.





Hanging doors starts with a drill press. After testing the layout on scrap, the author drills 32mm holes in the backs of cabinet doors (above). Pencil marks on the drill-press fence indicate the door-edge alignment. A jig locates screw holes for hinge plates inside the lower cabinets (right).



Assembly Is Speedy with Screws or Air-Driven Nails

I assemble the cabinets with glue and, depending on what will be exposed, either screws or air-driven nails. Because these base cabinets later received end panels, I used 16-ga. nails to assemble them and didn't worry about the holes. For the exposed sides of the wall cabinets, I used screws with integral washers. I used the same fasteners for the end panels and the exposed back of the kitchen island. I also used these fasteners to attach aluminum trim throughout the rest of the house.

Cabinets without backs are checked for square after they are assembled, then laid on the floor until the glue sets. Before installing any of these cabinets, I ran a router with a 1/8-in. roundover bit around the inside and



Pop on the doors. If holes have been drilled correctly, hinges installed on cabinet doors should snap easily into place on the base plates. These hinges allow the author to fine-tune the fit of the door.

outside edges of the fronts. This little profile also fools the eye if the cabinets don't quite line up when they are installed.

I hung the wall cabinets first (see the photo on p. 78) while they were easy to reach, then set the bases. Building cabinets in a lot of old, out-of-level, out-of-square houses has gotten me in the habit of building bases separate from the cabinets. I level the bases first (see the inset photo on p. 79), then set the cabinets on them. I like to spray the exposed toe kicks with black paint before the bases are installed. Then I set the cabinets (see the photo on p. 79) and attach finished ends and backs.

I made drawers like cabinet boxes and installed them before cutting parts for the doors and drawer fronts. Both the drawer fronts and doors are slabs of $\frac{3}{4}$ -in. Baltic birch.

When it was time to drill big cup-hinge holes on the back sides of the doors, I set

up a fence on my portable drill press. Pencil marks at $3\frac{1}{2}$ in. on both sides of the bit space out the hinges equally (see the top photo on the facing page). I can drill one hole, slide the door across the fence until the edge reaches the other mark, and drill the second hinge-cup hole. Before boring out a stack of doors, it is always a good idea to mock up a hinge on scrap stock to make sure that the layout is correct.

Before hanging doors, I ease the backs with a $\frac{1}{8}$ -in. roundover bit and the fronts with the $\frac{3}{8}$ -in. roundover to expose the edges of the birch plies. To hang doors, I made a plywood jig to drill holes for the hinge base plates (see the bottom photo on the facing page). When laid out correctly, the hinges snap easily together (see the photo above).

*Note prices are from 2001.

Joseph B. Lanza is a designer and builder who lives in Duxbury, Massachusetts.

Site-Built Kitchen

■ TONY SIMMONDS



I built my first kitchen 11 years ago. It included 20 ft. of base cabinets, 14 ft. of uppers, 6 ft. of full-height pantry units, a 4-ft. by 6-ft. cooking island, and a built-in computer desk. The job cost almost \$7,000, and it was the biggest commission I had undertaken in my fledgling shop. When I finally pulled up to the job in a 24-ft. delivery truck to install all the parts, I was sweating more from apprehension than exertion.

I took a look around while the driver and his mate started bringing in the cabinets. Funny how narrow an alcove looks when your pantry units are standing beside it. And who put that windowsill there? Was this the same house I measured?

As I walked around I got more and more panicky. I felt like Alice, alternately crowding the ceilings and then shrinking to the floor. It didn't seem remotely possible that what I had put together on the level, unencumbered surface of my shop floor could be reassembled here between these unaccommodatingly real, solid walls. The driver tapped my shoulder and pointed to one of the full-height units. It was lying on the floor next to its opening.

"Anything wrong?" I asked, with the sinking certainty that there was.

Don Watanabe, the site carpenter, was holding a level against the low ceiling over the cabinet's niche. The bubble was nowhere to be seen. Don smiled inscrutably. The converging lines of the finished floor and the ceiling weren't even close to parallel.

"Cheat it," he said.

Clean and simple. Waist-high drawers flank the stove in this site-built kitchen. The author made the edgebanded drawer fronts and doors out of a highly figured sheet of maple plywood. The cabinet carcasses, also made of maple plywood, are edged with thin strips of solid wood.

Take the Shop Along

Anyone who has built something in the shop for installation on a job site will recognize the scene. There are so many things to remember that it's nearly impossible to record all the data without dropping a detail here and there. And details can be expensive.

Three years ago, with my enthusiasm for plywood boxes flagging, I decided to get out of the full-time cabinet business and into remodeling. This has meant developing some different procedures for building cabinets and getting by with a no-frills complement of tools.

The heart of any cabinet shop is the table saw, and although I have learned to do a great deal with my old #1555 Rockwell® radial-arm saw, when it comes to building a kitchen, the table saw is indispensable. Mine is a 10-in. saw, and I use a thin kerf, 80-tooth carbide-tipped alternating-top-bevel blade on it. This makes smooth cuts in plywood, even across the grain. I still take along the radial-arm saw, though—partly because it's mounted in an 8-ft. table, which I use for everything from workbench to router table to extension supports for the table saw.

I won't pretend there aren't times when I miss the resources of the fully equipped shop, but for me the disadvantages of on-site construction are outweighed by the rewards. Principal among them is that the clients can be involved with the process at every stage—from layout to drawer pulls. If the clients don't like something, they can change it. If they get an idea, they can act on it, and they can do so without feeling that they are causing the construction schedule to run backwards while the meter runs forward.

With on-site construction, clients can be involved with the process at every stage—from layout to drawer pulls.

Maple-Plywood Cases

The installation I'll describe here was in a suite I helped my neighbors, Don and Shanti McDougall, build in their basement. By the time I got involved, the decisions still to be made centered on cabinet and counter materials and on door and drawer styles.

For the cases we settled on $\frac{3}{4}$ -in. paint-grade maple plywood. The sink counter would be plastic laminate, and the food-prep area would be wood. Economy and expediency dictated that we buy the laminated beechwood counter ready-made. I reckoned I could do the laminate work without involving another subcontractor.

We all liked the idea of a waist-level band of drawers (see the photo on p. 82). To these we added two deep bins on drawer slides next to the stove for pots and pans (see the photo below). The rest of the bases would be simple cupboards with hinged doors. Drawer fronts and doors were to be maple plywood, just like the cases.

With these questions resolved, I set about dimensioning the basic elements of the cabinets—the partitions, the floors, and the door and drawer fronts. They were all going to be the same material, so the first thing I did

was sort the sheets, selecting one with interesting color and figure for the doors. Then I had to figure out how to cut everything economically.

Paint-by-Numbers Layout

One thing I like about building cabinets on site is that I can usually pencil a full-size layout on the floor and on the walls too, if necessary. Then the job becomes almost like a paint-by-numbers kit: Cut the pieces and put them where they go in the picture.

I begin a layout by marking the length and the height of the last piece—the countertop—and work backwards. Before I settle on countertop dimensions, I make sure I know everything there is to know about the appliances that have to fit in and around the countertop. If I don't have an appliance on hand, I find it at a showroom and take very careful measurements. This is critical—fridges don't trim easily.

For this job the counter is 36 in. high and 24 in. deep. I allow an overhang of at least $\frac{1}{2}$ in. between the countertop and the face of the cabinets (usually the door or the

Under the doors and the drawer fronts. Shallow drawer boxes ride on wood runners affixed to the cabinet partitions and end panels. The lower drawers on the sink-side base cabinets are commercial bins that use roller hardware.



drawer face). With a smaller overhang, drips from the counter will run down the door front instead of onto the floor where they belong. At all costs avoid the sheer, modernist cliff, zero-overhang look. This style directs the drips down the inside of the door.

A cabinet end that is open to view should also have a ½-in. countertop overhang. But where a freestanding range (yup, they're still out there) has to be slotted between two runs of cabinets as in this case, I allow ¼-in. overall clearance between the finished ends of the countertops and another ¼ in. between the finished ends of the cabinets. This doesn't leave a great deal of space for jimmying a heavy stove into position, but face it: It's going to get dirty in there. The narrower the gap, the better.

The other overhang, between the door face and the toe kick at the bottom of the cabinet, is usually about 3 in. Remember to allow for the thickness of the finish material on the toe kick.

Pay particular attention to inside corners. One typical treatment is installing piano hinges between two doors at right angles to each other. This allows the doors to be opened and closed simultaneously. But what about the drawers above them? They need space to pass each other, and that space has to allow for any handle projection. I've found that a 1½-in. space between the inside corner and the beginning of the drawer allows for a wide range of handle choices.

Framing Cabinets in Place

The first step in building the cabinets (see the photo at right) is to establish a level base for them. For this kitchen I had to get ⅛-in. vinyl-tile flooring over ¾-in. underlayment, so I decided to set kiln-dried spruce 2x4s on edge directly on the subfloor. For a higher toe kick, or to allow for thicker finish flooring, I add furring strips to the tops of the 2x4s.



First the frame. The author assembled the base cabinets atop a frame of 2x4s toenailed to the wall and the subfloor.

With pieces cut and assembled, I set the completed frame on the layout lines. Then I check for level. If the high point is at the wall, I screw the back to a level line, then shim up the front as necessary and toe-screw the frame to the subfloor. If the floor slopes down from the middle of the room to the wall, I raise the back accordingly and fasten it to the wall like a ledger, shimming under it if necessary.

With a solid, level base frame in place, the next step is to cut the cabinet bottoms. One side of the kitchen shown here has a run of less than 4 ft., so I cut the bottom from one piece of ¾-in. plywood. When I need to join two or more pieces to make the bottom, as I did on the other side, I use a plate joiner and glue the pieces together as I lay them.

One advantage of site-built base cabinets is that the walls double as the backs of the cabinets, saving on the cost of a plywood back. On the other hand, the back edge of the cabinet bottom has to be scribed to the uneven plane of the wall (see the drawing on p. 86). This joint is practical rather than aesthetic, so I leave a gap that can be easily caulked, and I screw the bottom to the base. If screws are counterbored, they can be plugged later, but I don't plug them at this point in case I need to make minor adjustments after the doors are hung.

Next I cut the four cabinet end panels and the three partitions. I planned to flush-fit the doors and the drawer fronts, and because there was no back to allow for, the widths of all the end panels and the partitions were the same. If the bottom of the cabinet has been heavily scribed to accommodate a bulge in the wall, the partition or the end panel may have to be cut down correspondingly. As for height, the end panels overlap both the cabinet bottom and the top stretchers, so they're two thicknesses of plywood longer than the partitions. There's no reason you couldn't run the cabinet ends all the way to the floor, but you'd need to notch them for the toe kick, and you'd need a 35¼-in. long panel. I generally cut the longest panels at 31⅞ in. That way I can get three panels out of an 8-ft. length of plywood.

This is a good time to put at least some of the hardware on the cabinet end panels and partitions. Mechanical drawer slides and European-style hinge-mounting plates go on easier with end panels and partitions layed flat on the bench. For this job I used ½-in. by ½-in. wooden drawer slides screwed to the plywood.

Before I install the end panels and the partitions, I cut some strips of plywood about 3 in. wide for the ledgers and the stretchers. These plywood strips usually come from the offcuts of the cabinet pieces.

Next I select one partition and check that it's square and correctly dimensioned. Standing it upright on the cabinet bottom and flat against the wall, I pencil a line on the wall along the partition's top edge. I slide the partition along the bottom of the cabinet, marking the wall as I go. Now I can set the ledger to a level line.

I mark the position of the partitions on the front edge of the cabinet bottom and extend the lines across the cabinet bottom with a framing square. Then I use the partition, resting on the cabinet floor and flat against the wall, as a big square to draw plumb lines on the wall that mark the vertical lines of the partitions and the end panels.

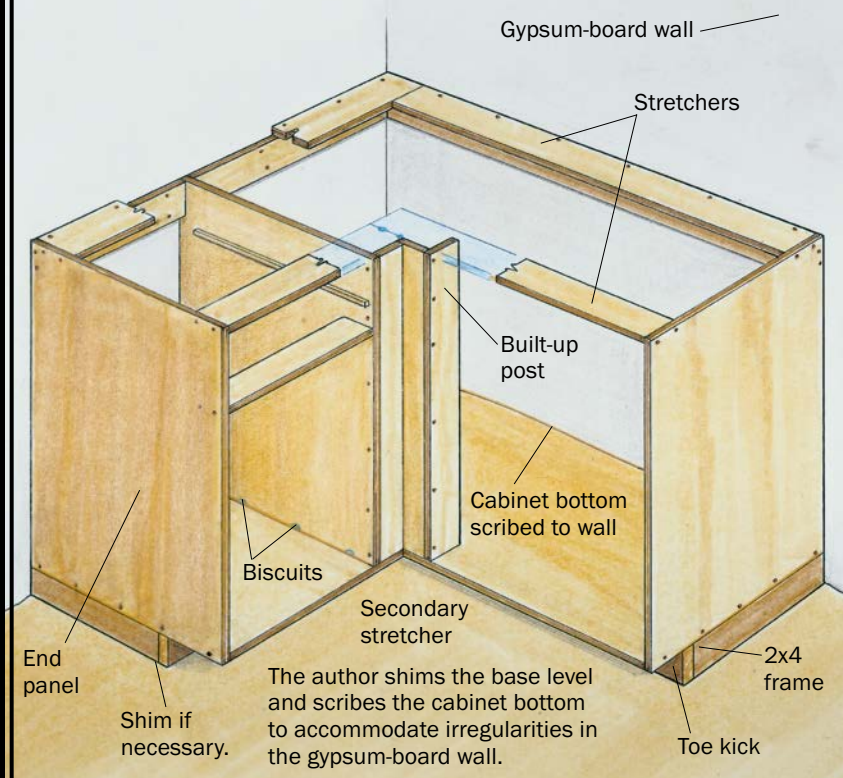
Ledgers Go Between Partitions

I join the partitions to the floor with biscuits, cutting the slots with a plate joiner. If there's a shelf between two partitions, I'll cut it now and use it to guide the plate joiner (see the drawing at left on the facing page). Otherwise, a spare piece of plywood can be clamped or tacked to the layout line as a guide.

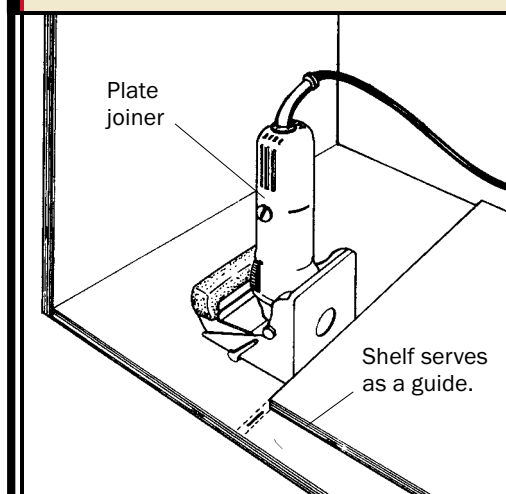
Once I have the slots cut for the partition biscuits, I can assemble the pieces. Beginning in one corner, I cut the ledger long enough to take me from the corner to the edge of the first partition. I screw the ledger

Cabinet Components

A site-built cabinet is a square piece of furniture built into a less-than-square environment, typically a wood-framed house. Ledgers screwed to the wall serve two functions: They anchor the end panels and the partitions, and they hold up the wall-side edge of the countertop.



Cutting Slots for Center Partition



to the wall, drop the partition onto its biscuits, and run a screw through the partition into the end of the ledger. Then I install the next length of ledger and partition and so on until I get to the end panel.

The stretchers are screwed to the end panels and the partitions. To keep things square and plumb while installing the stretchers, brace the end panel temporarily by pipe-clamping a piece of plywood about the size of your cabinet door in the opening the door will occupy.

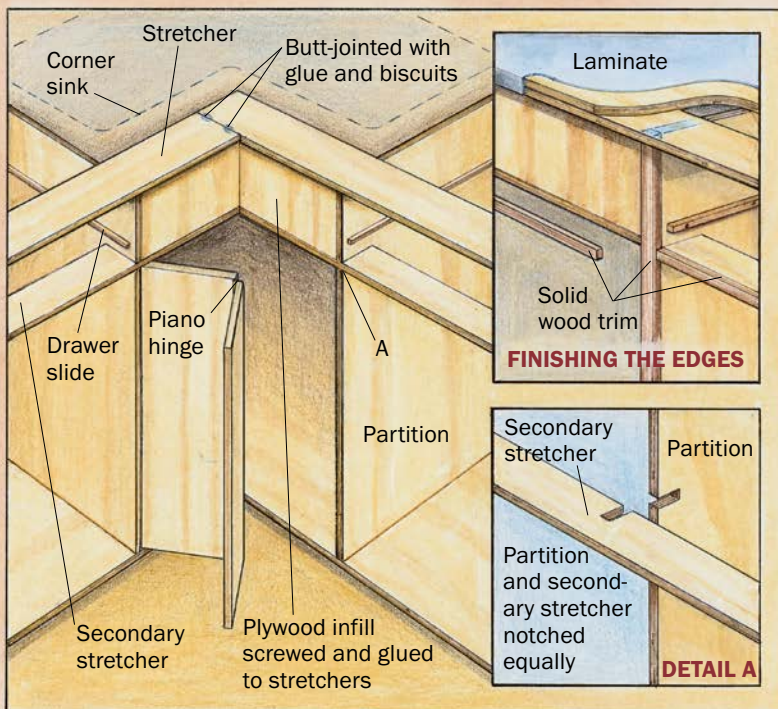
The back stretchers intersect at the corner of the walls. Make the butt joint there with glued biscuits or by screwing a piece of plywood across the joint from underneath. If you screw plywood across this joint, make sure it won't interfere with the door or the drawer.

In this kitchen I wanted to emphasize the division between the band of drawers and the doors underneath them, so I installed a secondary stretcher between them. Each secondary stretcher is screwed in place on the ends and half-notched into the front edge of any partition that it intersects (see the drawing at right).

To support the corner sink, I cantilevered the stretchers beyond the partitions and attached them to each other with a glued biscuit. I filled the spaces between the top and

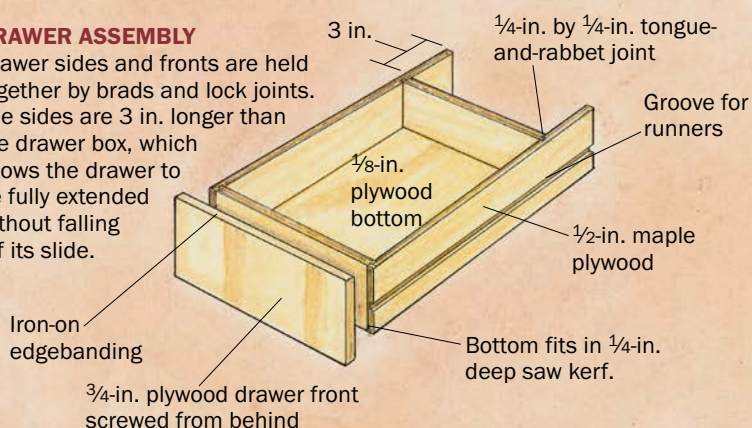
Sink Corner

Drawers fit between the top and secondary stretchers. At the inside corner, the stretchers cantilever beyond the partitions and are reinforced with plywood.



DRAWER ASSEMBLY

Drawer sides and fronts are held together by brads and lock joints. The sides are 3 in. longer than the drawer box, which allows the drawer to be fully extended without falling off its slide.



secondary stretchers with plywood, which acts like the webs of two short trusses. The corner is solid.

The other inside corner required a post made out of a couple of filler pieces to create a jamb for the cabinet-door hinges and clearance for the drawer (see the photo



Inside corner. A built-up post made of three strips of plywood serves as an anchor for the cabinet-door hinges. The post is secured at the top by screws through the stretchers and at the other end by a couple of finish nails into the cabinet bottom.

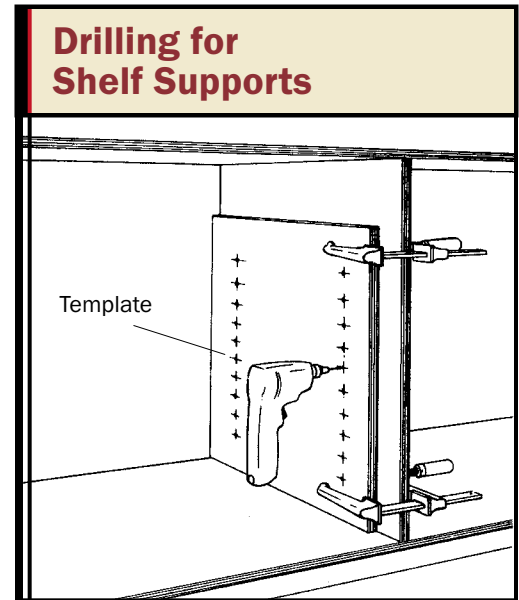
above). We did without a lazy Susan or a revolving-shelf fitting for this corner. If you're using one, make sure the corner post will accommodate its mounting brackets.

Mounting Shelves and Slides

I like to do all the work I can on the interior fittings of the cabinets before installing the countertop. There's more light in there without the roof, and countertops are susceptible to damage through misuse as workbenches.

Adjustable shelves used to be considered a luxury in a kitchen cabinet. Now they're practically *de rigueur*. I use the little spade-shaped nickel-plated steel shelf supports with a $\frac{3}{8}$ -in.-long shaft that can be inserted into a 7mm hole. I make a template with holes on 2-in. centers out of a strip of plywood as wide as the shelf, and I clamp it against the partitions and the end panels to guide my drill (see the drawing above).

To control the depth of the holes for the supports, I make a depth gauge out of a short length of dowel. I drill the appropriate-



diameter hole in the dowel and slip it over the bit. I use this depth gauge to avoid drilling through an exposed surface. Even where two sets of holes in a partition line up opposite each other, I drill from both sides using the depth gauge to avoid the tearout that occurs when a bit exits the back of the work.

When I finished with the template on this job, I ripped it in two and screwed each half to the inside corners where I would need shelf support, but there was no partition to provide it.

If you're using drawer slides, and you didn't mount them before installing the partitions and the end panels, you can make the job easier by using a plywood spacer. Shove it against the underside of the stretcher, butt your slide to it, and hold the slide steady while running in the screws.

Doors, Drawers, and Counters

The door blanks I cut earlier now had to be trimmed to size and have their drawer fronts separated from them. The grain pattern of the sheet I had selected made it important to do this carefully to preserve the flow of the intricate figure across the front of the cabinets, as well as vertically from door to drawer. I made sure I had a helper on hand to assist with the delicate table-saw cuts.

All four edges of the doors and the drawer fronts are bound with hot-melt glue veneer strips. This edgetape is available in several wood species and is easy to apply with a household iron (medium setting—no steam). It never fails to amuse a client if he happens to come in and see me in my apron doing the ironing.

I made the drawers for this job out of ½-in. maple plywood. I let the sides run 3 in. long to allow the drawer to extend all the way without falling off its runners. The width of the drawer should equal the face-to-face distance of the runners plus ½ in. The fronts and backs of the drawers are joined to the sides with a tongue-and-groove joint (called a drawer-lock joint) and glue and brads. For drawers of this size, I use ⅝-in. plywood bottoms, which fit in a regular saw kerf. To cut the ¼-in.-deep grooves for the runners, I run the assembled box over a ½-in. dado head with a plastic-laminate spacer added between the blades to make the grooves slightly larger. The runners are ½ in. wide, so the laminate provides the necessary clearance. I take care when assembling the drawers not to put any nails where the groove will be.

So-called European-style concealed cabinet hinges, with their several adjustments, have made hanging cabinet doors a snap. About the only thing you can do wrong is make the doors too big. I cut them to be ⅜ in. shorter and narrower than their

openings. The edgebanding adds ⅛ in. to that, leaving a ⅛-in. gap all around in the finished installation. The doors stop against a continuous strip of wood that is affixed to the underside of the stretcher. A continuous strip looks more like a trim piece than a little stop block, and it's easier to install. The edging I used for these cabinets was cut from a single piece of Douglas fir, which yielded a particularly crisp and pleasing pattern in its edge grain. The vertical edges are finished with ⅜-in.-thick strips, and the horizontal edges are capped with ⅝-in. strips, making for a stepped intersection that is more practical and more pleasing than is a flush one.

I hung all the doors and adjusted them, then I fastened the drawer fronts to their boxes with screws driven from inside the drawer. Where two or more drawer fronts are stacked on top of each other, as on the left-hand side of the range here, I install the bottom one first and then use a spacer (two thicknesses of edgetape is about right) to position the one above it.

I attached the wood counter to the stretchers with #8 wood screws driven into pilot holes for #10 screws. The oversized shank holes allow seasonal expansion and contraction of the countertop without splitting the wood. The countertop on the sink side of the range is plastic laminate installed over a substrate of ¾-in. AC plywood. We added a tiled backsplash with green grout to pick up the color of the deep-green laminate.

Tony Simmonds is a designer and builder in Vancouver, B. C., Canada.

Where two or more drawer fronts are stacked on top of each other, as on the left-hand side of the range here, I install the bottom one first and then use a spacer to position the one above it.

Building a Lazy Susan Cabinet

■ REX ALEXANDER



I have no idea who dreamed up the lazy Susan, but I bet a Hoosier had something to do with it. Indiana, after all, is the birthplace of the famed Hoosier cabinet, and Indiana is where I came across a lazy Susan corner cabinet for the first time. I had just started working as a cabinetmaker, and I landed a kitchen-remodeling job that included the removal of every cabinet but one, a corner cabinet that housed two lazy Susans. It was a primitive affair that probably had been built on site, but the owner loved it.

Made of standard lumberyard plywood, the cabinet took up a 36-in.-sq. space with a cutout in the corner. Both the bottom and center shelves supported 32-in. rounds of plywood that revolved on low-profile bearings. Even though I've upgraded the materials and hardware, and added solid-wood edging to the carousels, my lazy Susan cabinets are virtually the same (see the photos on the facing page). There wasn't much in that design to improve.

These cabinets hold a lot, and the 1,000-lb. capacity of the bearings means they work smoothly, even when the carousels are full of appliances or canned food. These cabinets eliminate wasted space in a corner, and they feature doors that open out of the way for easy access. Although I can buy factory-made lazy Susans, I think there are advantages to making these cabinets myself. My carousels are more attractive, operate more smoothly, and are a lot stronger than those flimsy trays revolving around a center pole. I can make mine any size. The 12-in. bearings of galvanized steel I use are inexpensive (about \$7* each) and readily available from woodworking-supply dealers and catalogs.

Start by Cutting Out Pieces for the Cabinet Box

Although I stick with $\frac{3}{4}$ -in. melamine for the cabinet box, I use $\frac{3}{4}$ -in. hardwood plywood for the carousel pieces because it's less likely to chip. To cut melamine cabinet pieces to size on a table saw, I use a Freud LU98, an 80-tooth blade with a triple-chip grind. For ripping plywood, I use a thin-kerf rip blade. I don't get fancy with joinery on these cabinets. A simple dado joint cut on the table saw works fine. I use zero-clearance table-saw inserts with all these blades.

After squaring and cutting the top, the bottom, and the shelf panels, I mark out 90-degree corner cuts on each piece. I start these cuts on a table saw (see photo below), but I'm careful not to cut too far and finish

Stop cut short of the line.

Cabinet top, bottom and shelf pieces are cut from $\frac{3}{4}$ -in. melamine. To avoid overcutting the 90-degree corner, the author stops the saw before the blade reaches the layout line.



Two ways to hang the doors. When clearance is not a problem, the author hangs doors on 165-degree cup hinges so that they meet at the center of the cabinet (see the bottom right photo on the facing page). If the cabinet is next to an appliance (see the bottom left photo on the facing page), the two doors are joined by a piano hinge at the center and hung so that they swing away from the obstruction.



Cut off the cabinet's back corner. To make installation easier and to eliminate wasted interior space, the author nips off the back corner of the cabinet top, bottom, and shelf. This table-saw maneuver is safe, providing the fence is long enough. If not, clamp or screw an auxiliary piece to the stock fence.



Finish with a jigsaw. With the workpiece on a pair of saw-horses, the author completes the cut with a jigsaw. A blade with downward-pointing teeth reduces splintering in the brittle top layer of melamine.

the cuts with a jigsaw (see the top photo above). Bosch® makes a 4-in., 10-tpi jigsaw blade (model T101BR) with its teeth facing down instead of up as in a standard blade. It reduces splintering in wood and chipping in melamine.

To eliminate wasted interior space in the back of the cabinet and to make installation easier, I cut a 10-in. piece off the top, bottom, and shelf pieces (see the photo above). This cut is easily done on the table saw with the points up against the fence.

After the pieces for the cabinet have been cut to size, I then build the carousels for the lazy Susan. The 32-in.-dia. circles are cut from $\frac{3}{4}$ -in. maple plywood. I use a plunge router and a solid-carbide spiral bit to make them.

Carousel Pieces are Made with a Template or a Trammel

Because I make lazy Susan cabinets frequently, I have a 32-in.-dia. plywood template for cutting out the circular carousel pieces. I screw down the template to the plywood (see the top left photo on the facing page) and make a half-dozen or so shallow cuts around the edge to produce a carousel piece (see the right photo on the facing page). If you will need a template only rarely, it may make more sense to use a trammel of $\frac{1}{4}$ -in. plywood to make the carousel pieces. The trammel should be about 20 in. long and the width of your router base (see the bottom left photo on the facing page).



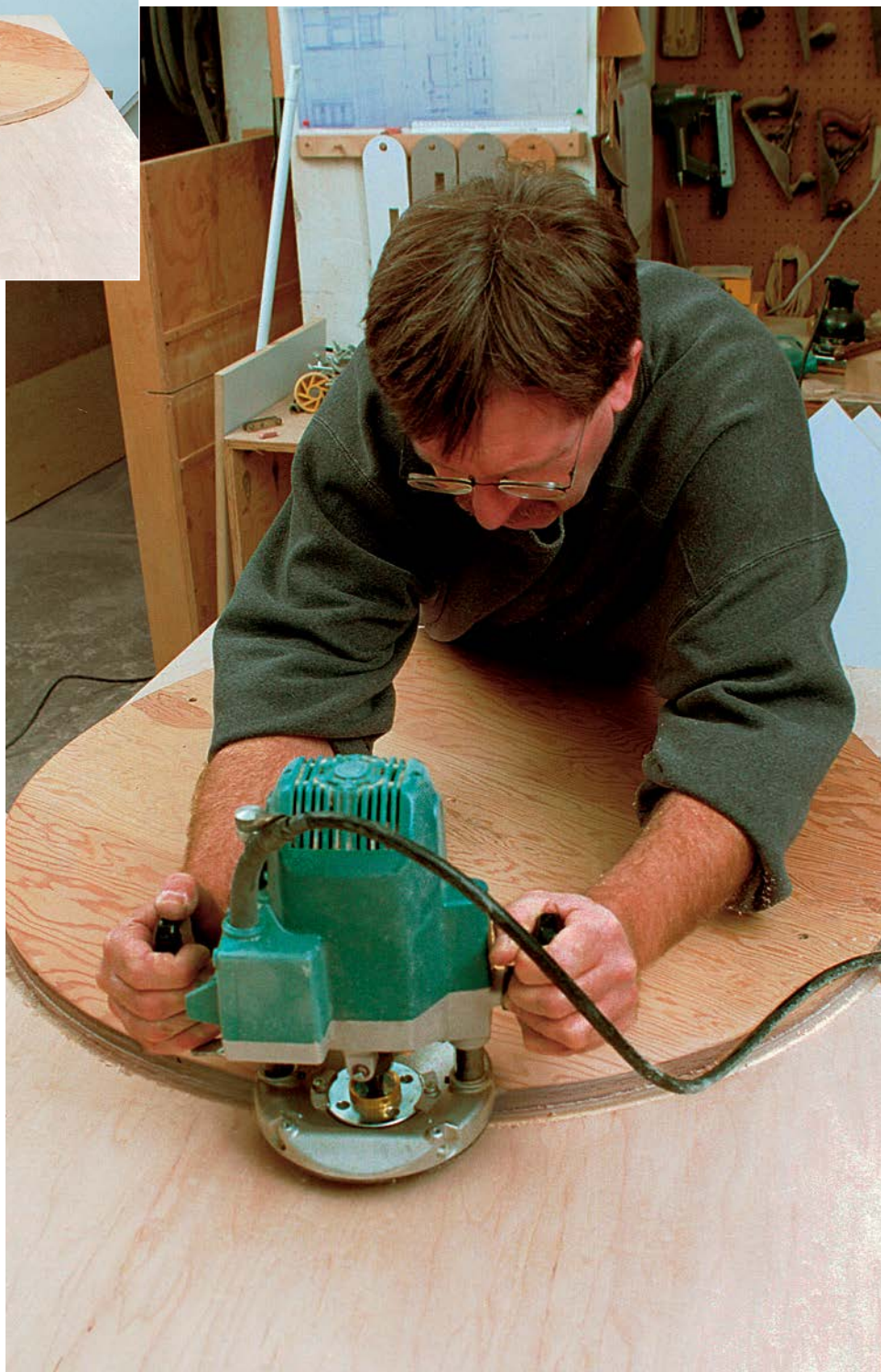
A template makes the work go faster. To make plywood carousel pieces, the author starts with a 32-in.-dia. plywood template that is screwed to $\frac{3}{4}$ -in. maple plywood. If you don't want to make a template, try a trammel attached to the router (see the photo at bottom left).



Making a perfect circle.

A trammel made from $\frac{1}{4}$ -in. plywood that pivots on an 8d nail is a good substitute for a circular template. To cut a 32-in.-dia. carousel, set up the router so that the distance between the nail and the inside of the router bit is 16 in.

Use a guide bushing and light passes. With a solid-carbide spiral bit and a guide bushing, a router makes a clean cut in maple plywood around this reusable template. Cuts should be light— $\frac{1}{8}$ in. per pass.



Mark and cut the carousel. The author centers a plywood carousel on a cabinet top, bottom, or shelf piece. Before marking it for the 90-degree cutout, he moves the carousel toward the front of the cabinet $\frac{1}{4}$ in. to compensate for hardwood edging. A splinter-free blade is a good choice for taking out the pie-shaped piece on the carousel. The author finishes with a low-angle block plane and a chisel for a clean edge.



Add the edging. Straight-grained maple $1\frac{1}{2}$ in. high is glued to the perimeter of the carousels to create a lip that prevents contents from sliding off as shelves are turned. The author uses yellow glue and a web clamp to attach the edging.



To mark the 90-degree cutouts, I place the carousel pieces on the top, bottom, or shelf piece, adjusting them so that they are evenly spaced, and then mark the cut from below (see the top left photo above). I use a jigsaw to make the pie-shaped cut (see the right photo above) and clean up the cut with a low-angle block plane and a chisel.

Plywood carousels are banded with a thin strip of wood. This edging piece must be high enough to keep the contents of the

lazy Susan from falling off as it is rotated, and thick and low enough to resist splitting if it is bumped. After a lot of experimentation, I now use clear, straight-grained maple $\frac{7}{32}$ in. thick and $1\frac{1}{2}$ in. wide. A piece $88\frac{1}{2}$ in. long gives me enough to wrap around a 32-in.-dia. carousel with a little bit to spare. A band clamp with a rapid-action ratchet, available from Woodcraft Supply (800-225-1153), works well for gluing (see the bottom photo on p. 94). I apply a bead of aliphatic (yellow) glue to both the plywood and the maple edging. C-clamps or spring clamps can be used to hold the edging in place while you put the nylon webbing in place. Glue squeeze-out should be cleaned up with a damp cloth.



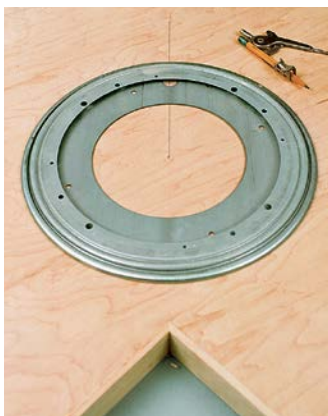
Outside corner is reinforced with brads. A potential trouble spot is the outside corner of the carousel, where edging pieces meet. Here, the author adds some $\frac{3}{4}$ -in. brads. Drilling pilot holes will prevent splitting.

Finish Up the Edging, and Attach the Bearings to the Carousels

I leave the band clamp on for 24 hours to make sure that the glue bond is good. Then I square the ends of the edging, cutting them close to flush with a dovetail saw and trimming them flush with a low-angle block plane. The two remaining pieces of the edging can then be glued and pin-nailed to the 90-degree cutout. I think that it's a good idea to nail the outside corner where the edging meets with a $\frac{3}{4}$ -in. brad as a further guard against separation (see the photo below).

For added strength, I apply preglued veneer to the outside edges of the carousels. The veneer covers and strengthens the butt joints, making them look mitered, and it gives the edging a full $\frac{1}{4}$ -in. thickness. I apply it with a household iron set between "cotton" and "wool," and press it down with a J-roller. It can be trimmed with a utility knife.

Carousels should be finished before they are mounted on the waiting cabinet parts. I apply as many as six coats of precatalyzed lacquer, a tough and wear-resistant top coat. Precatalyzed lacquer is a highly flammable, solvent-based finish that should be applied in a spray booth. Whenever possible, I spray outside. If you don't want to bother with this kind of finish, I'd suggest Enduro® poly (800-696-0615), a water-based finish that can be brushed on.



Lay out hardware location. With the carousel upside down, the author centers the lazy Susan hardware. A line drawn through the centerpoint is used to locate a hole for mounting the carousel.



Drill an access hole. Once hardware has been attached to the bottom of the carousel, the only way to screw that assembly to the cabinet will be through a $\frac{3}{4}$ -in. access hole in the carousel.

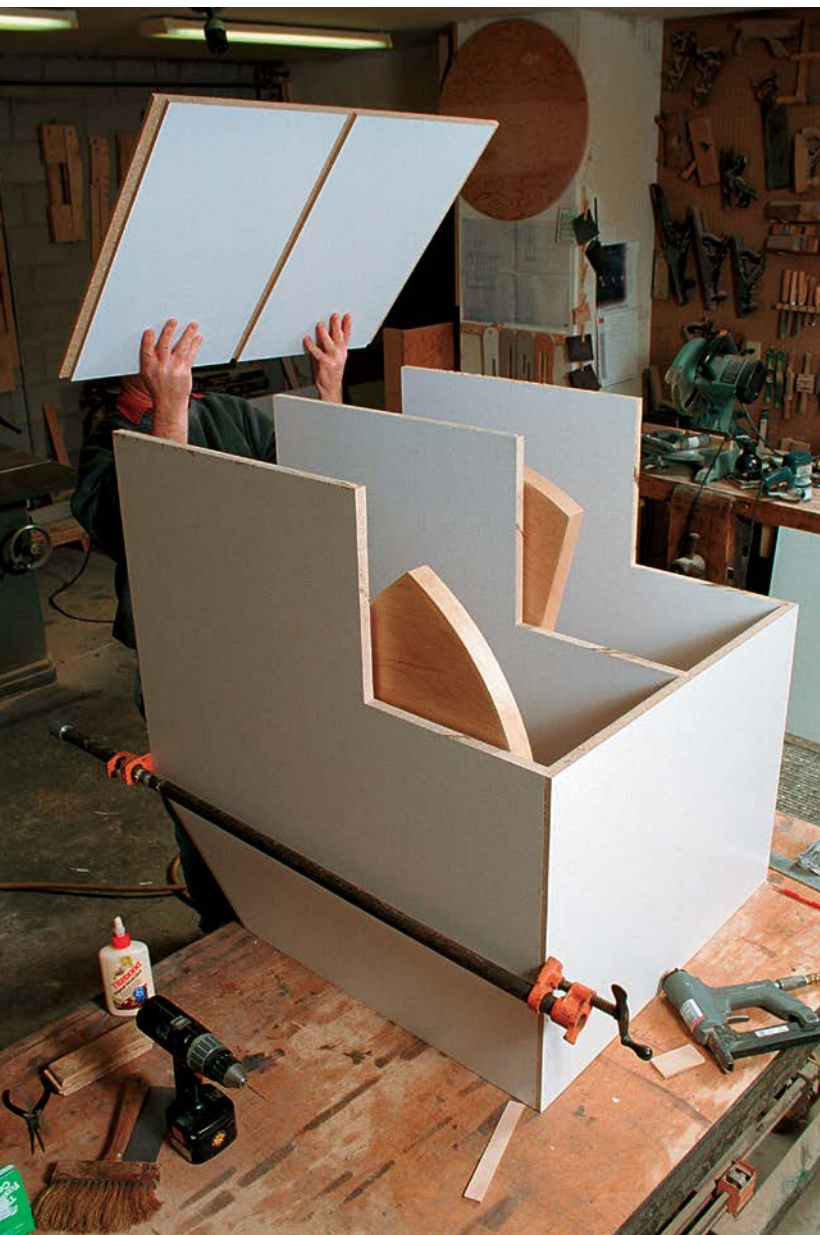


Attach hardware to bottom of carousel. After the carousels have been finished, the author flips them upside down on a padded bench and adds the lazy Susan hardware.

Assembling the Carousels and Completing the Cabinet

Installing the lazy Susan bearing is a two-step process: Start by attaching the hardware to the carousel, then screw that assembly to the cabinet shelf or cabinet bottom. When both bearings are attached, the cabinet can be assembled. The bearings I use have a

$6\frac{1}{2}$ -in. hole in the center, plus a $\frac{3}{4}$ -in. access hole in the bottom flanges (see the top left photo). With a compass at the center of the carousel (use the hole left from the template or trammel), I draw a $6\frac{1}{4}$ -in. circle. Then I draw a straight line from the point of the 90-degree opening to the carousel's centerpoint. I line up the bearing with the circle and set the access hole over and centered on the bisecting line. I mark the access hole with a pencil and drill halfway through with a $\frac{3}{4}$ -in. spade bit (see the bottom left photo). Finish the drilling from the other side.



Putting it all together.

Dado joinery is simple and strong and makes for speedy cabinet assembly once all the pieces are ready. The author will cover raw particleboard edges in the cutout by ironing on preglued polyester tape.



Now mount carousels on cabinet parts. Working through the access hole, the author attaches a carousel to the cabinet shelf. After inserting a screw, the author revolves the carousel until the next screw hole appears below the access hole.

After screwing the bearing to the bottom of the carousel (see the right photo on the facing page), I flip over the piece and place it onto the bottom cabinet panel. I make sure the carousel spins evenly, and then screw it into place through the access hole (see the right photo above), turning the carousel until the access hole exposes an empty screw hole below. After that, assembling the cabinet goes quickly. I use yellow glue on the dado joints and fasten the pieces with narrow-crown 1-in. staples in a pneumatic nailer

(see left photo above). When I'm gluing on the back, which is a melamine-to-melamine joint, I make sure to use a glue made specifically for this material.

I finish by ironing on preglued polyester tape to the 90-degree cabinet opening and trimming any excess with a utility knife. Doors are hung on cup hinges.

*Note prices are from 2000.

Rex Alexander is a cabinetmaker specializing in kitchens. He lives in Brethren, Michigan.

Working with Melamine

■ REX ALEXANDER

A crosscut box protects the finish and makes clean angles. Squaring off panels of melamine is clean and fast with a crosscut box. If a panel is too large, mark it with a square and carefully trim the edge on the table saw.



A few years ago, I remember, I was admiring the cabinets in my sister's new kitchen until I opened a cabinet door and saw melamine. My stomach turned. In those days—before I knew better—I tried to persuade any customer who specified melamine to use something else, usually a hardwood plywood with filled grain and catalyzed-lacquer finish.

Then one day a customer on a tight budget brought me his kitchen plans. The upper cabinetry would be open birch shelving; the base units would house drawers behind doors. With this design, I discovered I could use melamine on the interiors and shave \$2,000* off the total kitchen price—in part because melamine is cheaper than hardwood plywood (\$29* per sheet vs. \$50* per sheet) but also because the finishing is already done, which cuts out a great deal of expensive sanding and brushing or spraying.

Satisfying a customer with beautiful hardwood exteriors is one thing, but when I can add the surprise of a clean, washable cabinet interior at a lower cost than hardwood plywood or high-pressure laminate (HPL), my custom cabinetry becomes hard to resist. I sold the job and have used decorative laminated panels almost exclusively for cabinet interiors since.

What's exciting about this product for me as a contractor and cabinetmaker is that the decorative surface of this material is similar in characteristics and advantages to HPL, but I don't have to do any laminating. What's more, delamination of thermofused melamine is virtually nonexistent because there's no layer of adhesive to dry or deteriorate over time. Also, decorative panels are available in wood grains and in almost every color and texture that can be found on a string of HPL chip samples. Panels are also manufactured in thicknesses from ¼ in. to 1¼ in. and in sizes from 4 ft. to 5 ft. wide and 6 ft. to 18 ft. long.

Melamine's variety of colors, patterns and textures makes it useful for furniture and cabinetry in the home (see the photo at right),



A durable, easy-to-clean surface. Melamine-laminated panels are easy to make into furniture or cabinets, such as this bathroom cabinet of melamine with a plastic-laminate counter surface. Melamine doesn't need finishing and can be machined with tools found in the standard home shop.

Clearing up the Confusion About Decorative Laminated Panels

Melamine is a resin used to saturate special decorative paper, which is either laminated by hot-melt adhesive or thermofused to a substrate. Once cured, these processes produce a surface thinner than but similar to the plastic laminate used for kitchen countertops (called high-pressure laminate, or HPL).

Your local lumber dealer may use the term melamine to describe micropaper, foils, or thermofused melamine. Each contains melamine resin in varying amounts; all are decorative laminated panels. A decorative laminated panel is developed when a substrate of particleboard, medium-density fiberboard (MDF), or plywood is laminated with a protective or decorative surface. How the surface is made and laminated to the panel distinguishes one from another.

Micropaper, or “rice papers,” are low basis-weight papers that are top-coated with acrylic, polyester, or other resins to improve strength. Basis weight is measured in grams per square meter before top coating (micropapers weigh 23g to 30g). The more resin added, the greater strength and wear characteristics. The paper is laminated to the substrate with hot glue and heat-cured in a drying oven.

Micropapers are available only in wood grains, are limited in their ability to resist water, “fuzz” when routed,

and aren’t thick enough to cover substrate imperfections, so their uses are limited. However, micropaper is perfect for vertical surfaces, exhibits and displays, furniture, and some cabinet interiors. Its low cost and wood-grain reproductions are inviting features.

A step above micropaper are foils, cellulose-paper overlays that have basis weights of 60g to 80g, generally are fully saturated with a resin system or urea formaldehyde, and cured using heat or light. Because the resin in the paper does not form an integral bond with the substrate, foils can’t be considered low-pressure laminates. Resin-saturated foils have good wear characteristics, flexibility, a better ability to cover substrate imperfections, and good print and wood-grain reproductions. They’re also available in solid colors. I use foils for the interior backs of cabinetry and occasionally for sides, tops, and bottoms. Because foils do not repel water completely, I don’t recommend them for sink-base cabinetry, bathroom vanities, or high-wear horizontal applications.

Heavier thermofused melamine is available in a variety of basis-weight papers, ranging from 80g to 140g. It’s made in a two-stage process that begins by submerging this special decorative paper in a clear, sticky liquid resin of melamine or polyester. It’s flexed

office, and even in some commercial applications. And when I think back to my sister’s kitchen cabinets, I realize how confused I was about decorative laminated panels and the generic lumberyard term “melamine” that is used for them (see the sidebar above).

I consider thermofused melamine the best of the decorative laminated panels. It has a tough surface, good wear resistance, and excellent water resistance. It also won’t peel away from the substrate. Thermofusing gives it that hard, durable surface. And although some specialized techniques are needed to work with the material, it can be used in most home shops.

I Was Skeptical About Melamine, So I Did Some Tests

When I first started using melamine, I studied a brochure from a manufacturer that showed the different colors of melamine and listed some of the characteristics of the material. The brochure also included the performance standard for thermofused, or thermoset, decorative panels, but I was skeptical and performed a couple of simple tests. First, I placed a soaked washcloth on a thermofused surface. The next day, I was pleasantly surprised to find the washcloth dry, the water evaporated, and the overlaid surface undamaged.



Get a variety of finishes with decorative laminate. Decorative laminate, better known as melamine, is available in a variety of types, thicknesses, and colors.

and bent to open the fibers and allow thorough resin saturation, then drawn through a dryer.

During the second stage, the resin-saturated paper is laid over particleboard, MDF, or plywood and fed into a press where it's subjected to high temperature and pressure (around 350 psi, as opposed to HPL, which is

pressed up to 1,400 psi), which permanently fuses the overlay to the substrate. Heat and pressure transform the resin back into a liquid so that it penetrates the fibers of the substrate. Once thermofusing is completed, the chemical change results in a hard, durable surface that won't melt.

Thermofused melamine can be found in most local lumberyards. If you have difficulty finding the product, the American Laminators Association (P. O. Box 2209, Seattle, Wash. 98111-2209; 206-382-1671) will direct you to the closest manufacturer. I store sheets of melamine flat in a clean, dry environment of normal temperature and humidity.

My next concern was about fasteners. I'd used particleboard before and wasn't pleased with the way it held a screw. Because the melamine I used had a particleboard substrate, I was afraid that if someone accidentally ran into an open door, the hinge might pop off. I consider the European cup hinge to be one of the best on the market, so I installed a set of 120-degree hinges to a door and side panel of thermofused melamine. After a lot of abuse that included running into the door and actually bending the hinge, I was pleased to find that the hinge's base plate hadn't budged. The overlaid surface actually strengthened the substrate.

Building upper cabinetry of $\frac{3}{4}$ -in. thermofused melamine for the sides, top, and

bottom, and a $\frac{1}{4}$ -in. foil-covered panel for the back posed another worrisome situation. Glue won't stick to melamine. I usually glue and staple a $\frac{1}{4}$ -in. back to a cabinet and then glue two $\frac{3}{8}$ -in. by 3-in. strips of hardwood or plywood over the back at the top and bottom. These backs add support to the screws that hold the cabinet to the wall. However, the foil surface on the $\frac{1}{4}$ -in. back wouldn't hold glue so I decided to test the strength of the foil back by stapling it every 2 in. to a piece of $\frac{3}{4}$ -in. thermofused melamine, both with particleboard substrates.

I fastened a small hardwood strip to the foil back and clamped the melamine to the workbench with the foil and the hardwood projecting off at a right angle. Then I roped

a 60-lb. toolbox to the piece and left for the weekend. Monday morning, the toolbox still hung from the piece, and the ¼-in. back and screw block were firmly in place. For an ultimate test, I added my 170 lb. to the mix by standing on the toolbox. The joint passed the test.

This Brittle Material Is Best Sawn Using a Specialty Blade

Thermofused melamine has a hard, brittle surface, so before cutting it, I make a zero-clearance throat for my table saw. I usually have sink cutouts left over from a laminate-countertop job and cut one to fit the throat

of my table saw. With the blade lowered, I slowly raise the blade through the throat ⅝ in. above the panel.

I've found that a Freud LU85 80-tooth precision cutoff blade or an LU98 80-tooth chip-free laminate blade (Freud, 218 Feld Ave., High Point, N. C. 27263; 800-472-7307) works best. The LU98-80 is made especially for two-sided material. I feed the panel through the saw at about the same speed I'd rip hardwood. Both sides will have minimal chipping and usually none at all. A 4x8 sheet of ¾-in. melamine weighs close to 100 lb., so I get help maneuvering these panels around. I apply Johnson's Paste Wax to the table-saw table and outfeed table to minimize scratching.

To get clean right-angle cuts, I trim the panel pieces using a crosscut box on my table saw (see the photo on p. 98). This box, which is simple to make, rides in the miter-gauge slots of the table saw. Not only is it safer to make crosscuts this way, but it also protects the melamine from scratches.

A Router Works Like a Joiner to Clean Up Chipped Edges

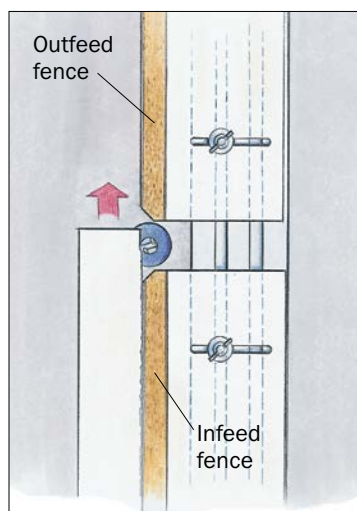
As I mentioned earlier, glue won't stick to the surface of melamine. So I join my cabinets with dados and rabbets, which expose the particleboard substrate and allow me to glue the joints. First, I make another zero-clearance saw throat for my table saw, this time for use with a carbide-tipped dado blade. I cut a ⅜-in.-deep by ¾-in.-wide rabbet into the top and bottom edge of each side panel of base cabinets (see the photo at left) and a full dado for the bottoms of upper cabinets. This cut creates a recess under the upper cabinets for housing the undercabinet lighting I always recommend.

I assemble base cabinets after a careful check of all exposed edges for chips. Outside edges usually will be covered by another cabinet or by applied end panels, so chips there won't be seen. If I decide to use a cabi-

Cutting a rabbet exposes a glueable surface. The author cuts a dado on the top and bottom edges of side panels and on bottom and side edges of drawer fronts so that he can glue the exposed substrate.

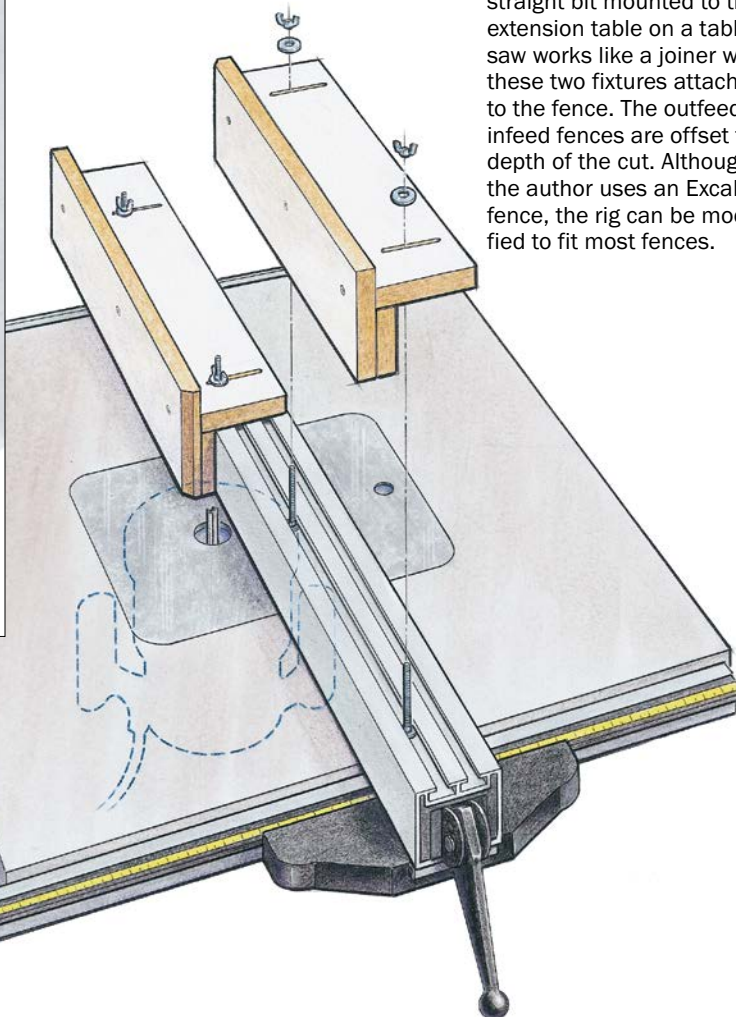


Fixtures Turn a Router into a Joiner



TOP VIEW

The wing nuts allow the two fences to be adjusted to the depth of the cut.



A router with a carbide-tipped straight bit mounted to the extension table on a table saw works like a joiner with these two fixtures attached to the fence. The outfeed and infeed fences are offset the depth of the cut. Although the author uses an Excalibur fence, the rig can be modified to fit most fences.



Routing cleans up exposed edges. If an edge is exposed, this router and fence allow any chipped edges to be removed cleanly.

Iron-on edge tape must be rolled, then trimmed. Raw edges of melamine are easily and quickly covered (below) using a roll of polymer tape and a household electric iron to melt the adhesive backing to the edge of the panel. Before the edge tape cools, it is thoroughly rolled with a J-roller and then trimmed (right) with an edge-trimming knife that is made for shaving away excess laminate tape.



net side for an exposed end panel, I use a homemade router fixture that works as a joiner to clean any chipped edges (see the drawing on p. 103).

To make the fixture, I mount a 3-hp router under the extension table attached to my table saw. Using pieces of $\frac{3}{4}$ -in. thermo-fused melamine, I build a pair of L-shaped brackets that fit over my Excalibur precision table-saw fence (Excalibur Machine Tool Co., 210 8th St. S., Lewiston, N. Y. 14092; 416-291-8190). Carriage bolts fit into slots that are machined into the top of the fence, and the L-shaped brackets fit over these bolts, with slots cut into the brackets to make them adjustable. Washers and wing nuts hold brackets in place and allow fence adjustments like the infeed and outfeed tables on a joiner.

A router delivers a constant speed of 8,000 rpm to 22,000 rpm, so you get a clean

cut on figured wood, which makes this setup perfect for edging melamine. I use my router/joiner for cleaning up an occasional chip if the end panel will be seen or when I use melamine for doors and drawer fronts. Over-cutting end panels, doors, and drawer fronts $\frac{1}{32}$ in. on each edge and then cleaning them up using this technique guarantees a perfect edge. I usually use a $\frac{3}{4}$ -in. carbide-tipped straight bit in the router.

An Electric Iron Welds the Edge Tape on Melamine

Covering raw, exposed edges on this laminate is a quick, easy task that I do before assembling the pieces. I use either a preglued polymer tape, which makes an edge that matches the melamine, or preglued raw hardwood tape (both available from Direct

Supply, 1055 36th St. S.E., Grand Rapids, Mich. 49508; 616-245-4415). These tapes are applied with a regular household iron.

Setting the iron dial indicator between permanent press and wool, I keep the iron steadily moving so that the tape doesn't scorch. Polymer tape is easy to scorch, and I often drape a cotton cloth over the edge to prevent that from happening. After ironing on the tape, I quickly follow with a vigorous rolling with a J-roller (available from most woodworking suppliers that sell veneer) (see the photo at left on the facing page).

To ensure full coverage, the tape is wider than it needs to be, but trimming the excess is easy. I use a standard utility knife and then an edge-trimming knife (available from Trend-Lines®, 135 American Legion Highway, Revere, Mass. 02151; 800-767-9999) (see the photo at right on the facing page). I suppose you could trim the edges with a block plane, but these edge-trimming knives are cheap and really do the job right.

I take extra care when filing or sanding the preglued edge because it's easy to go through to the substrate. If I discover small, serrated chips after I've ironed on the edge, I file or sand these even, down to the substrate. If a hardwood tape is used, these wood lines usually disappear when a finish is applied. They stick out like a sore thumb if a polymer tape is used, but a colored lacquer carefully applied to this line will cover the problem.

A Brad-Point Bit Works Best for Drilling Melamine

Regardless of whether I'm using drawers or shelf pullouts, I next install all epoxy-coated drawer glides and hinge base plates. Installing all of the hardware before the cabinets are assembled sure beats wiggling around inside a base unit and fumbling with the drill, glide, and screws. It's necessary to drill a pilot hole to accept a #6 flat-head wood screw, or the screw can pull loose. Without

a pilot hole in thermofused melamine, the screw would wander. Also, screwing into the substrate without first drilling a pilot hole pulls out the material, leaving a crater.

I use a hole-drilling template (available from most woodworking catalogs) and a high-speed steel brad-point bit to drill holes for the shelf supports. The brad-point bit I use is made from heat-resistant, high-speed tool steel and features specially ground, extra-long spurs (available from Woodcraft Supply, 210 Wood County Industrial Park, P. O. Box 1686, Parkersburg, W. Va. 26102-1686; 800-535-4482). This bit actually scores the melamine before drilling into the substrate, which leaves a clean, chip-free surface for mounting a shelf support.

I have seen, time and time again, melamine interiors with adjustable shelves where the shelf clips work their way partially out of the hole and chip or disfigure the hole. With plywood cabinets I use a Knappe and Vogt® 346 steel shelf support with a ¼-in. steel pin that fits into the hole. I like this support because when the shelf is registered firmly against it, there's no way it can work itself out. But these supports only come in metal finishes, and with melamine I want something white to match the interior. I used a Hafele white-plastic shelf support (Hafele America Co., 309 Cheyenne Drive, P. O. Box 4000, Archdale, N. C. 27263; 800-334-1873) with a grooved plug and spring clip. These supports fit snugly in the hole, and the spring clip locks the shelf in place.

Gluing and Clamping Hold Pieces When Screws Won't Do

With Titebond® glue applied to each edge of the raw joints, I either pin, staple, or drill a pilot hole and use drywall screws to hold my cabinets together. I have never had a problem with any of these fasteners. Occasionally, if I have a cabinet in which extra-heavy kitchen supplies will be stored or if I

Take extra care when filing or sanding the preglued edge because it's easy to go through the substrate.



Rabbeted edges are glued and clamped. Glue doesn't stick to laminate, so the author rabbets, glues, and clamps the pieces to get a tight, durable fit.

prefer not to use fasteners because of their exposed ends, I clamp the joint to ensure that there is a good bond (see the photo on the facing page).

Once the top, bottom, and sides are together, I square the cabinet and attach a ¼-in. foil back to it by stapling it every 2 in., which is quicker and cleaner than rabbeting the cabinet to receive the back. I predrill holes every 3 in. along the top edge of the base units and install 2-in. drywall screws. This process reinforces the area where the cabinet is screwed to the wall. I use foils for backs because they cost less and work fine for low-use vertical surfaces. Handling foils can be tricky because sliding one panel on top of another could result in scratches if there's a foreign body between the panels. Decorative laminated panels should be given the same care as any decorative surface.

After the back is in place, I apply ¾-in. by 3-in. hardwood or plywood strips along the top and bottom edges at the back of the upper units, gluing and screwing these strips in place every 3 in. after the backs are stapled every 2 in. This step adds more support to the installed cabinet. I've also used ½-in. melamine glued and screwed to the backs of the upper units. However, the edges of this



Holes in the laminate can be repaired. Screws can sometimes pull out of the material and leave a gaping hole like this one. It can be filled with a mixture of 5-min. epoxy and paint.

back have to be rabbeted first because glue won't stick to melamine.

Sometimes when I build bookshelves or when I think an upper unit needs more support, I install ¾-in. by 2-in. melamine strips on the inside top and under the bottom in the cavity I leave for undercabinet lighting. These strips can be screwed from the sides, top or bottom.

Flaws can be Filled In or Smoothed Away

Final cleanup of a melamine cabinet is easily done with a mild, nonabrasive, all-purpose cleaner and a soft cotton cloth. Before using a cleaner, though, I first use compressed air or a vacuum brush to remove sawdust, metal filings, or other particles from the cabinet's surface. Harsh chemicals should not be used on melamine.

Small scratches and minor blemishes usually show up at this point. These flaws usually can be treated with a light spray wax, which fills in scratches like car wax on a car. I've also used a maroon Scotch-Brite® pad or 0000 steel wool for removing tougher scrapes. You should take care not to rub too hard, which leaves a dull surface.

Once in a while, a tool or some other object will accidentally dimple the surface. Using the wrong-size drill for a pilot hole will sometimes cause the screw to pull the material out, leaving an unsightly scar (see the photo above left). Both situations can be neatly repaired using the appropriate universal color (which can be bought at any paint store or hardware store that sells paint) mixed with a five-minute epoxy. After the epoxy cures, I take a very sharp cabinetmaker's chisel and pare the excess off level with the surface. Small chips on the edges can be removed this way, too.

*Note prices are from 1996.

Rex Alexander is a cabinetmaker, specializing in kitchens. He lives in Brethren, Michigan.

Make Your Own Laminate Countertops

■ STEVE MORRIS



The substrate is critical. To ensure accuracy, the author fabricates the substrate where it will be installed. Here, he's truing a particleboard edge by guiding a router against a straightedge.

Choosing a kitchen countertop is a big deal. The surface has to be durable, attractive, and complementary to the kitchen's style. The decision becomes more difficult when you consider cost. You can spend thousands of dollars on the countertops for an average kitchen, but you don't have to. Fabricating and installing a laminate countertop can save you loads of money.

The popularity of expensive countertop materials like granite, solid surface, and engineered stone makes it easy to overlook the appeal of plastic laminate. But laminate countertops still have the durability and beauty to compete with more expensive options, and there are more colors and patterns to choose from than with any other material.

Making your own laminate countertops doesn't require many tools, and the price of materials—laminate, particleboard, and contact cement—is insignificant. You can make countertops in a garage or in a basement, or you can work outside if the weather is nice.

Start with a Custom Fit

One benefit of laminate countertops is that they can be made to fit large, oddly shaped areas without seams. Sheets of laminate are available as large as 5 ft. by 12 ft. But before I get to the laminate, I have to build a substrate. The substrate is the structural part of the countertop to which the laminate is glued. Whether I am fabricating a large, oddly shaped kitchen countertop or a small bathroom-vanity top, I prefer to prepare the substrate in place—right in the kitchen, in this case (see the right photo on the facing page). This way, I can be sure the finished countertop will fit correctly.

Particleboard is the best material to use for the substrate, and fortunately, it is the least expensive. Plywood is too grainy, and medium-density fiberboard (MDF) is too heavy. Particleboard is strong enough to do the job and provides a smooth surface

Endless Choices and Unbeatable Prices

These days, everyone wants kitchens full of granite and stainless steel because they are durable and attractive. But before you write off laminate as a choice for your kitchen countertops, consider this: Among only a few major laminate suppliers, there are hundreds of styles and colors to choose from. From the look of stone, metal, and glass to wood-grain patterns and solid colors, there is a style and color to complement any kitchen or bathroom. Laminate is available in different grades, including fire-rated, chemical-resistant, and abrasion-resistant materials. Laminate is durable and easy to work with. The edges take a number of interesting treatments, including simple bevels and wood nosings. And laminate costs as little as \$2* per sq. ft. Add the cost of the substrate, the glue, and your time, and laminate countertops still cost a fraction of the alternatives.



Laminated edges have the look of solid-surface material.



Wood nosing can be made to match the cabinets.



A half-round nosing softens the countertop edge.



Preparing the Substrate

Walls can be bowed, and corners aren't always square. If you measure, mark, and cut the particleboard substrate in place, you can make sure that the countertop fits the cabinets and the walls.



Scribe now, not later. The substrate should fit flush against the wall, and the overhang should be consistent along the length of the cabinets. Scribe and cut the particleboard to fit the walls now to avoid having to cut the finished countertop during installation.



If you can't avoid a joint, try to plan the least-obtrusive places to join the particleboard pieces that will make up the countertop. Overlapping two pieces allows you to mark the exact location of the joint. You can cut particleboard to size with a circular saw. For smooth, straight edges, run the saw against a straightedge guide.

for laminate. I use 1 $\frac{1}{16}$ -in. particleboard to make my countertops.

If the kitchen is large enough to set up sawhorses and if the room can be sealed to contain dust, I work right in the kitchen. Otherwise, I set up outside. I measure from the walls to the edges of the cabinet frames and add $\frac{3}{4}$ in. Later, when I add wood strips to the edges, the overhang will increase to 1 $\frac{1}{2}$ in. If the cabinets have full-overlay doors and drawer fronts, the result will be a finished overhang of $\frac{3}{4}$ in. (see the drawing on p. 112).

I cut the particleboard with a circular saw guided by a straightedge. Then I put the substrate in place to make sure it fits well. This

often means scribing the particleboard to the walls. It is safer to cut the scribes on the blank substrate than to cut the laminated top during installation.

I avoid joining sheets of particleboard when I can. Sometimes, however, joints are inevitable. Preparing the substrate in place allows me to determine the best spots for joints. Even with thorough filing and sanding, particleboard joints can show up in finished countertops. For this reason, I try to hide the joints in corners or under the top cabinets.

Particleboard sheets are joined with biscuits and countertop bolts. On a 2-ft. joint, I use four biscuits and two bolts.



Biscuits and bolts work together. Mark biscuit locations every 6 in. A pencil line across the joint is all you need to align the biscuit joiner. Bond each joint with yellow glue. Hidden on the underside of the substrate, countertop bolts clamp the joint together.

The T-shaped mortises for the bolts are cut freehand with a router and a ½-in. straight bit. The biscuits help with surface alignment, and the bolts pull the joint together. I then file and sand the top of the joint to make sure it is smooth.

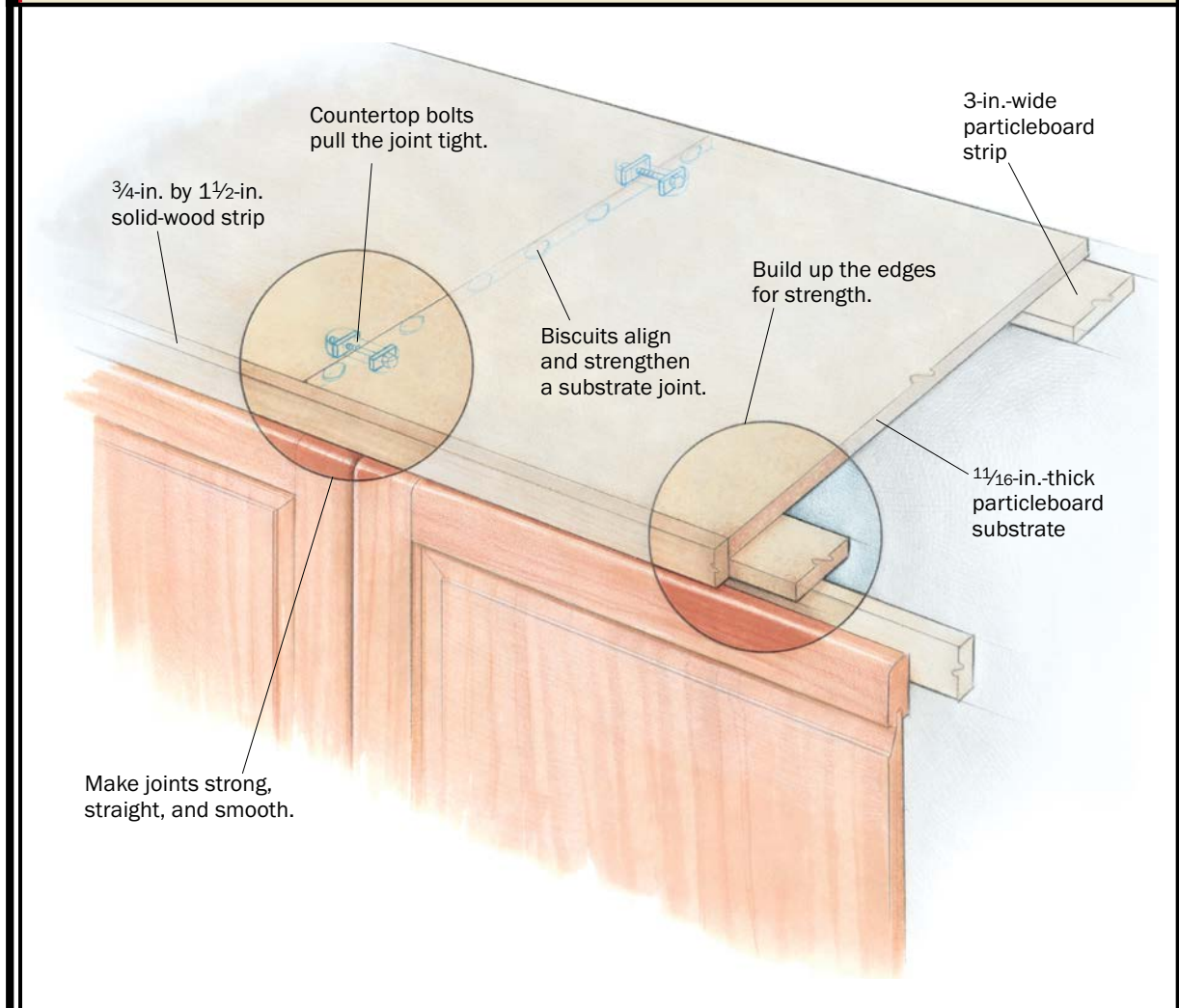
Build a Stronger Countertop

To provide strength and to make the countertop look 1½ in. thick, I reinforce the edges with 3-in.-wide strips of particleboard. Along the front and along any exposed edges, the strips are glued and nailed flush and are sanded smooth with a belt sander. In the

back, where the countertop meets the walls, the strips are recessed about ¼ in. Any area at which the countertop overhangs the cabinets by more than 6 in., such as a bar top, is doubled up entirely.

Attaching ¾-in. by 1½-in. hardwood strips to the front edge of the substrate is the next step. The wood strips stiffen the surface, which is helpful when installing long countertops. The wood also gives the vulnerable front edge of the countertop some extra hardness and durability, and it accepts contact cement better than the porous cut edges of the particleboard.

Use Particleboard for Substrate



Double up the perimeter. Build up the edges with particleboard strips. On the edges that will be laminated, attach the strips flush with the top. On the back edges, recess the strips about 1/4 in. to ease any scribing that has to be done. Glue and nail solid-wood strips along the front edge. The wood strips stiffen longer surfaces and accept contact cement better than the cut edge of particleboard.

Be Careful with the Laminate

Until it is glued to the substrate, plastic laminate tears and cracks easily. It is important to treat large pieces carefully. I leave the laminate rolled up in the box until I am ready to work with it. Laminate can be cut in various ways, but I use a laminate trimmer or a small router with a sharp laminate bit. A dull bit will chip the laminate.

The laminate is first cut oversize, then trimmed after it is glued to the substrate. I clamp the sheet of laminate to a large table or a sheet of plywood and cut 3-in.-wide strips for the edges. Then I cut the top pieces of laminate on the prepared substrate, where I can follow the shape of the countertop. The cutoffs must be supported, or they will crack.

Joining pieces of laminate is tricky. Never rely on the factory edge of the laminate to be straight. If you are joining large sheets, use a laminate trimmer or a router with a straightedge and trim both pieces to make sure they are straight and square. Cut edge strips to length with a miter saw. Sandwich the laminate strip between two scraps of particleboard, and make the cut through the particleboard and the laminate.

Laminate the Edges First

Contact cement is sticky, so work slowly when you are gluing the laminate. Once you glue down a piece of laminate, you probably won't be able to get it off.

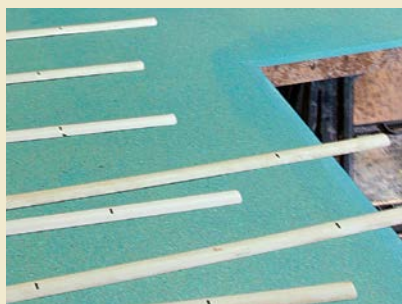
I use latex contact cement because it is nontoxic and nonflammable (www.lepage-products.com). Both the laminate and the substrate get two thin coats of contact cement. Two thin coats dry faster than one thick coat. Because the particleboard will absorb some of the contact cement, the first coat is used to seal the pores, while the second coat remains on the surface, where I want it. Allow the contact cement to dry

Three Tips for Working with Laminate

Use Venetian-blind slats as spacers between the substrate and laminate sheets to make sure the laminate is aligned properly before the two glued-up surfaces are allowed to touch.

For a clean-cut laminate edge, first cut a longer strip than you need. Then put the end of the strip between two scraps of particleboard and cut it with a miter saw.

Laminate warmed up with a heat gun or a hair dryer is easy to bend. Pull the laminate gently while applying heat. At first the laminate will resist, but after a few minutes, it will bend.



1. Venetian blinds make great spacers.



2. A laminate sandwich makes for clean cuts.



3. Heat laminate to make it flexible.

completely between coats and before applying the laminate to the particleboard.

The edges are laminated and trimmed first. After the edge strips all are applied, I press them to the substrate with a roller. I use a heat gun to bend edge strips into and around radiused corners. Heating the laminate

Laminating the Countertop

Get the front edges done first, then turn to the top. Once the glued-up laminate and substrate meet, it's difficult to separate them. Starting with oversize pieces of laminate and aligning the top on spacers helps to prevent mistakes.



Edges first. After adhering a laminate edge strip along the front edge of the countertop, trim it flush. A bearing-guided flush-trimming bit gets the job done.

Latex doesn't stink. Use a roller to apply two coats of latex contact cement to the substrate and the laminate. Make sure the contact cement is dry on both surfaces before gluing them together. Spacers keep the two adhesive-coated surfaces apart while you position the large top sheet of laminate. When you're ready, remove the spacers, starting in the middle of the countertop and working out toward the edges.



helps to prevent cracking as it bends. Pushing a heated edge piece into a curved inside corner is more difficult than turning an outside corner. Any voids that are left between the laminate and the substrate will be filled with epoxy before the top laminate goes on.

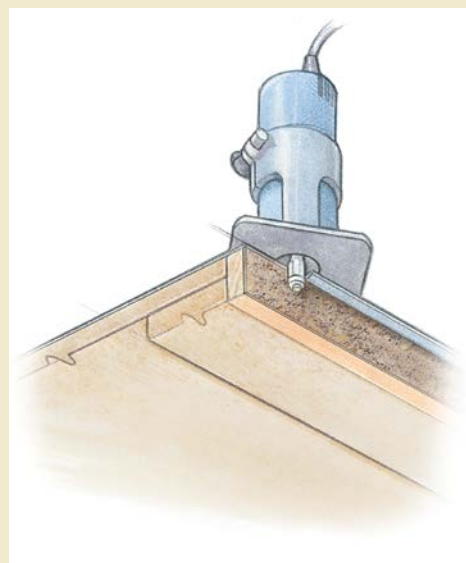
To trim the edge pieces flush, I usually use a bearing-guided flush-trimming bit, which can be chucked in a laminate trimmer or a small router. After the edges are trimmed, I give the top of the substrate a final check to make sure it's flat and smooth. Slight irregularities near the front edge—

between the particleboard, the wood edging, and the laminate—can be removed with a file or a belt sander.

Align the Top Sheet Carefully

Before applying contact cement to the top of the substrate or the laminate, these surfaces should be dusted with a brush or air hose to remove debris. Even a tiny piece of debris will show through the laminate.

To line up large sheets of laminate without letting them touch the glued-up sub-



Final steps. Press the laminate to the substrate with a roller to ensure a good bond. Check the surface for air bubbles as you go. Then trim the top flush with the edges. Finish up by smoothing the top and bottom edges and all corners with a wood or laminate file.

strate, I use Venetian-blind slats as spacers. The laminate is placed on top of the spacers and positioned as it will lay on the substrate. Starting in the middle of the countertop, I work my way toward the ends, removing the spacers and pressing down the laminate. To ensure a good bond, I use a roller to press the laminate to the substrate.

If I find an air bubble, I heat the laminate from the bubble to the nearest edge to create an exit for the air. If that doesn't work, I can drill a small hole ($\frac{1}{16}$ in.) through the bottom of the substrate to get the air out from under the laminate.

The oversize sheet of laminate then can be trimmed around the edges of the countertop. Use a light touch with the laminate trimmer or router to avoid marking or scratching the laminated edges. Because the cut edges of the laminate can be sharp, the last thing I do is lightly file the top and bottom edges and all the corners with a hand file.

*Note prices are from 2004.

Steve Morris is a finish carpenter and kitchen installer in Sarnia, Ontario, Canada.

Hardwood Edgings for Plastic Laminate

■ PAUL LEVINE



Take a look at a European-style kitchen, and you'll probably see a lot of plastic panels: plywood or particleboard covered with plastic laminate. So much plastic can give a kitchen an austere, almost clinical look. That's why I use solid hardwood edgings (see the photo at left) with plastic laminate. Besides being more durable than edges of plastic laminate or veneer, solid wood is nicer looking, and it's easy to add attractive design details by subtle shaping.

Cut It on the Table Saw

For starters, smooth, square edges mean a crisp fit between the plastic and the hardwood. So when I'm making cabinets and countertops, I glue the laminate to oversized pieces of plywood and then cut each piece to its final size on a table saw. This way, the

Easy on the eye. Besides covering the plywood edges, hardwood edging adds a warm accent to plastic laminate. Doors and drawers are edged with $\frac{1}{4}$ -in. strips while the countertop has a $\frac{3}{4}$ -in. bullnose.

laminate edges are perfectly flush with the plywood edges and much cleaner than those produced with a trimmer bit. For this operation, I use a triple-chip design, 80-tooth, crosscut blade. I also made an auxiliary fence that has a 1/2-in. by 1/2-in. wood strip attached 1/8 in. from the table surface (see the drawing at right). When I cut the pieces, the straight edge of the plywood, not the excess laminate, rides against the wood strip, and I'm guaranteed a straight cut.

Sometimes prelaminated plywood is too cumbersome to cut on a table saw. That's when I follow the traditional method—cut the substrate to its final dimensions first, then apply the laminate and trim it to size with a laminate trimmer.

Jointed Edges Glue Better

I like to rip my edging about 1/4 in. wide for door and drawer panels. This dimension is both visually pleasing and wide enough to clamp easily. To provide one clean edge for gluing, I joint the stock before ripping each 1/4-in. strip from it. Edging should be at least 1/16-in. thicker than the panel's thickness to allow for flush trimming after it has been applied.

Make all your edging at one time to ensure consistent dimensions throughout. If some of the strips emerge wavy or crooked, start afresh with another board with straighter grain. Wavy stock is difficult to glue up, and later, when it's time to flush up the edging with a handplane, wavy grain will be more likely to tear out.

Mitered Corners

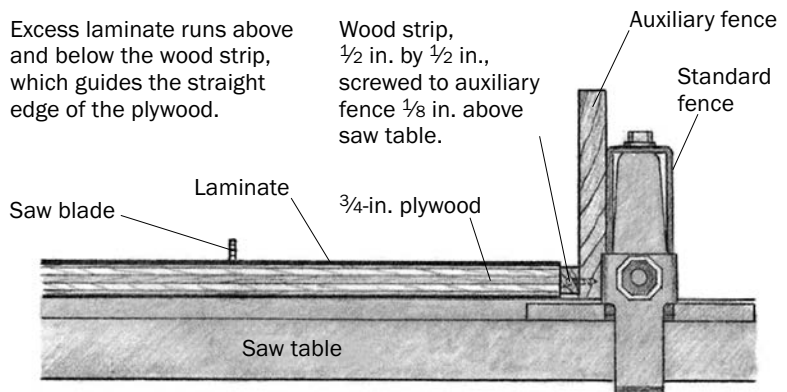
There are two ways to join edging at the corners of a door or a drawer. A mitered joint looks better than a butt joint, but it's also more difficult to achieve. If you choose to miter the corners of the edging, measure the two long pieces first (most doors and drawers are rectangles), mark the edging and cut a miter on both ends. I like to cut

Cutting Plywood

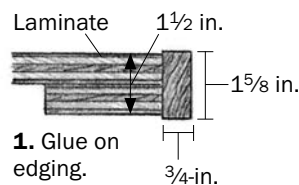
RIPPING LAMINATED PLYWOOD

Excess laminate runs above and below the wood strip, which guides the straight edge of the plywood.

Wood strip, 1/2 in. by 1/2 in., screwed to auxiliary fence 1/8 in. above saw table.



MAKING A BULLNOSE EDGING

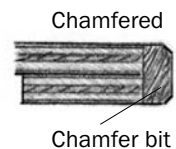
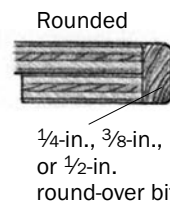
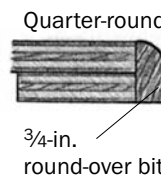
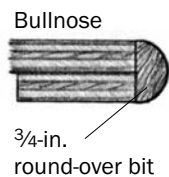


2. Trim edging flush top and bottom, using a router and a trimmer bit.



3. Round over top and bottom using a 3/4-in. round-over bit.

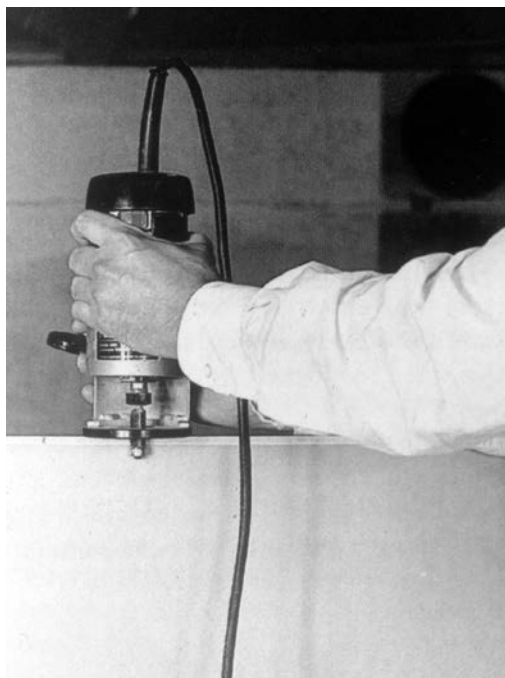
HARDWOOD-EDGING PROFILES



the edging, slightly long first and then trim a hair off, testing the fit between cuts. If I cut too much off, I just use the piece on a shorter side.

Once the edging fits perfectly, spread yellow glue on it and then seat the edging, sliding it back and forth a bit to make the glue tacky. Masking tape will help hold the edges in place. Then clamp opposing sides, leaving them clamped for at least two hours. If you use pipe clamps, 1/2-in. wooden shims placed under the pipes will hold them off the laminated face of the door or the drawer. This will keep clamping pressure parallel to the edging and will also prevent the iron pipes from staining the material. Scrap stock

It's a nose, not a lip. After the glue has dried, run a router fitted with a 1-in. trimmer bit along the face to trim edging nearly flush. Then shave the stock flush with a block plane.



the same length as the edging makes a good clamping pad that will help distribute pressure evenly along the joint. Scrape off excess glue or remove it with a damp rag to save cleanup time later.

After the glue has cured, the edging must be trimmed flush with the face of the panel. With a 1-in.-long ball-bearing trimmer bit in my router, I remove most of the excess (see the left photo above). The bearing runs against the face, leaving the edging slightly proud of the panel surface. To avoid tearout, I run the router from right to left (against the rotation of the bit), then make a final cleanup pass in the opposite direction.

Next, trim the slight lip that remains with a block plane that's set to take a fine shaving (see the right photo above). This may take some getting used to, but with practice—and as long as you keep the tool level—you can get a sharp plane iron to ride across the surface of the plastic without scratching it. Use straight-grain edging, plane with the grain, and keep the plane sole flat on the laminate surface. Follow these precautions, and you'll probably never damage the laminate. Still, any accidental nicks can be repaired with Kampel SeamFil® (Kampel Enterprises, Inc.,

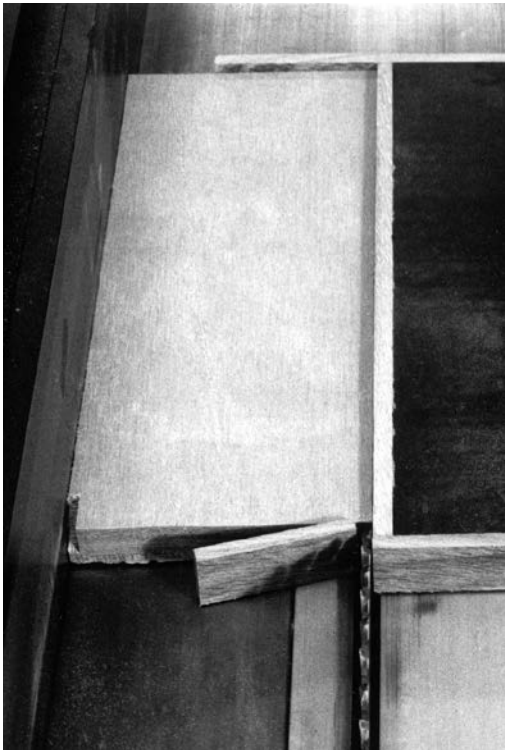
8930 Carlisle Road, Wellsville, Pa. 17365), a puttylike filler for plastic laminate. To avoid tearing out the edging at the corners, start at each corner and plane toward the center of the edging.

How do you know when to stop planing? One indication is when the plane no longer cuts. Another is when the slight buildup of glue squeeze-out disappears, exposing a clean, crisp joint.

Once the edging is flush, chamfer or round-over the front corner with a sharp chamfer or quarter-round router bit equipped with a ball-bearing pilot. Feed the bit into the work slowly, and you will be rewarded with a surface that requires no sanding. The back corner of the edging, which faces the inside of the cabinet, should be eased with 100-grit sandpaper.

Butted Corners

I think a well-mitered corner looks best, but a neat butt joint beats a sloppy miter. The methods I use make butt-jointed edging even easier to apply. Panels should be ripped to their exact height but left about $\frac{1}{4}$ in. wider than the finished size. Then cut the



Taming the wild edges. Butt-jointed edging is applied long, then trimmed on the table saw. A block of plywood provides a reference edge.

horizontal edging no wider than the width of the plywood and glue it to the top and bottom edges.

Next, trim the edging flush to the laminate surface with a trimmer bit in the router. Then cut the panels to their exact final width, less the thickness of the vertical edging. This way you'll be cutting the horizontal edging flush with the edge of the panel in the same operation, which saves a lot of fussy fitting and ensures a perfect butt joint.

When the vertical edges of the panel have been trimmed, glue on the remaining edging, letting the pieces run long. After the glue has set, trim the excess edging on the table saw (see the photo above). I lay a block of plywood on the table saw as if I were going to take a blade's width off it. I use this block as an auxiliary fence; with it I can trim the long edgings nearly perfectly and fine-tune the results with some sandpaper. Be consistent in the way you orient the butt joints. If you apply the horizontal edging first on one panel, do the same for all the other panels. Just remember that the sides you edge first will have the exposed butt ends.

A Nose for Countertops

My countertops typically overhang doors and drawer faces by $\frac{3}{4}$ in., or the thickness of the wood nosing that I usually apply, which looks just right. Again, the surface will have to be laminated before you apply the nosing. Once the surface laminate has been applied, even up the front edge either on the table saw or with a laminate trimmer.

The $\frac{3}{4}$ -in.-wide nosings I install are about $1\frac{5}{8}$ -in. thick, or slightly thicker than the countertop, and are applied in the same manner as the edging on doors and drawer faces. First, glue and clamp the nosing to the front edge of the countertop using yellow glue. When the glue has dried, use a 1-in. trimmer bit to remove most of the excess wood on both the top and the bottom of the counter and plane the nosing flush with a handplane. That done, you can give your nosing any profile you like. I prefer a bullnose, so I use a $\frac{3}{4}$ -in. radius round-over bit in a router fitted with a $\frac{1}{2}$ -in. collet. (I would not attempt it with a $\frac{1}{4}$ -in. shank bit.) This is too big a cut to make in one pass, so I make two passes on each edge. To minimize tearout, I run the router from right to left for the first cut, then finish it off in the opposite direction. After routing, I carefully sand the bullnose with an orbital sander, using 100-grit and then 150-grit paper.

Paul Levine of Sherman, Connecticut, is a cabinetmaker and author of *Making Kitchen Cabinets* (The Taunton Press, 1988).

Building Concrete Countertops

■ FU-TUNG CHENG WITH ERIC OLSEN

Concrete is a wondrous material. It has substance and mass, permanence and warmth. It assumes forms that irrevocably touch our daily lives: bridges, floors, walls, and now even countertops. I built my first concrete countertop with a friend in 1985 and was so encouraged that I began to design and build more of these “working sculptures.” After learning to control the process, I’ve made concrete my design material of choice in kitchens and baths.

The first step in building a concrete countertop is making the mold (see the left photo on the facing page), a task that offers opportunities for creativity but one that demands lots of attention to detail. A mold doesn’t require sophisticated materials or techniques, but the process can be conceptually challenging because the mold is a mirror image of the finished piece. When you construct a mold, you’re essentially building what is not in the countertop.

For my crew and me, a common project is a mold for a simple rectangular kitchen countertop that includes an undermounted sink, a faucet, a dishwasher air gap, and an

integral drain board. As for any project of this sort, mixing and pouring the concrete are vital processes for a durable countertop.

The Template Comes First

Countertop layout begins with the template (see the photos on p. 122), which defines the size and shape of the countertop. It also records details such as walls that are out of square and becomes the notebook on which to write essential information such as the location of cabinet bays, plumbing, and appliances.

For template material, we use 3-in.- or 4-in.-wide strips of hollow-core door skins (1/8-in. plywood), but 1/4-in. lauan plywood, foam board, or even stiff cardboard works, too. The template begins with one long strip placed along the back of the cabinets. A second strip establishes the front edge, overhanging the cabinet by 1½ in. After checking that the front piece is parallel with the face of the cabinets, we tack the strips in place temporarily with a couple of small finish nails.



Upside down and backward.
An elegant countertop (above) starts with an elegantly detailed mold (left) that is built as a mirror image of the finished piece.

Two crosspieces define the counter's ends and are cut short so that they fit in the outer edges of the back and front strips. More crosspieces define the sink bay. Once all the pieces are in place and the template is square, we use hot-melt glue to attach the crosspieces to the front and back strips. We hold or clamp each glued joint until the glue has hardened.

Before removing the template from the cabinets, we note pertinent information on

it, such as the position of the faucet. It's a good idea to note on the template which side is the top, along with the front and back edges, especially if you're making the mold off site. This all may seem obvious, but we've learned the hard way that such details aren't always so clear once we've returned to the shop.

Build the Mold on a Solid Table

We recommend building the mold on a large, level table made with a $\frac{3}{4}$ -in.-thick plywood top over a grid of 2x4s. The $\frac{3}{4}$ -in. top allows us to screw up from beneath the table into the bottom of the mold when we can't secure the mold from above. For the mold, we use $\frac{3}{4}$ -in. melamine. The material is inexpensive, holds up well, and produces a smooth, predictable concrete surface. After cutting the basic rectangle that establishes the mold's dimensions, we cut strips for the mold sides and the sink box. We then assemble the parts of the mold.

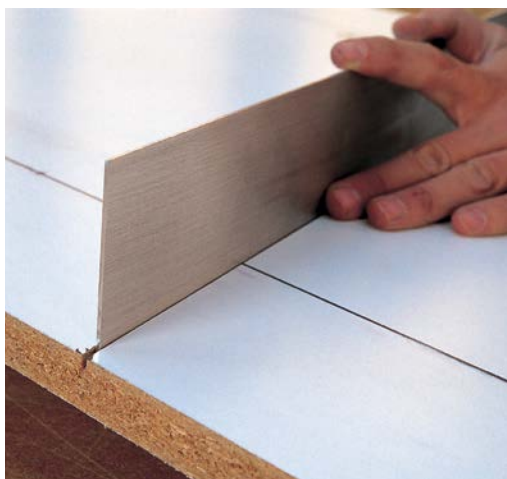
The Dividing Channel

To make handling the counter easier and to reduce concrete's natural tendency to shrink and crack, large countertops such as this one usually are divided into smaller sections with $\frac{1}{16}$ -in.-thick aluminum channel. Once the template information has been transferred onto the mold, the next step is to cut a saw kerf into the bottom of the mold for the dividing channels (see the photos on the facing page). In this example, we ran the dividing channels on the diagonal. Aluminum makes the best dividing channel because it's strong and easy to cut with a carbide blade. However, it must be coated with a waterproof sealer such as polyurethane or shellac so that it will release after the concrete has cured.

Template defines the countertop's shape.

A template (right) made of thin plywood strips hot-glued together is an accurate means of transferring the shape of the counter onto the mold. After notations are written on the template indicating site particulars, the template is flipped over (remember, the mold is upside down), and the information is transferred onto the melamine blank (bottom).





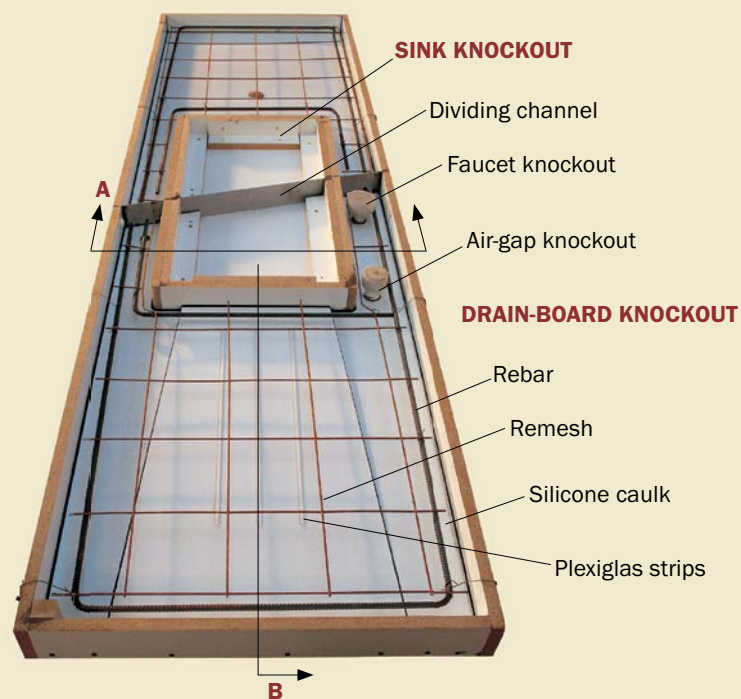
Dividing channel is a thin piece of aluminum that separates the counter into smaller sections that are easier to handle and shrink less when cured. The aluminum is set into a single saw kerf that's cut into the mold's bottom.

The Integral Drain Board

Forming the integral drain board is the next step (see the bottom drawing on p. 124). Cut from one end of the mold bottom, the three cuts that describe the drain board should be made at about a 7-degree angle away from the board's center so that the mold will release more easily. A ½-in. plywood shim glued to a routed recess in the mold's underside creates the drain board's incline. Strips of Plexiglas® or wood also can be glued to the drain board to create space for brass rails that will be epoxied onto the finished countertop.

Anatomy of a Countertop

The mold must duplicate the size, shape, and elements of the countertop but in the negative. In the mold, every space is filled with concrete while solid parts called knockouts become spaces for the sink, drain board, faucets, and other elements.



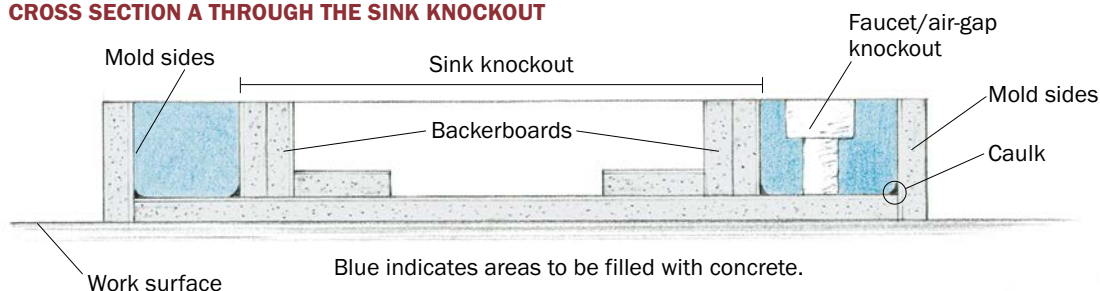
The Sink Knockout

The sink knockout can be made of melamine pieces reinforced by L-shaped backboards or cleats. Because the sink knockout for this mold was divided by the aluminum channel, it had to be made with six pieces of melamine, plus their respective backboards.

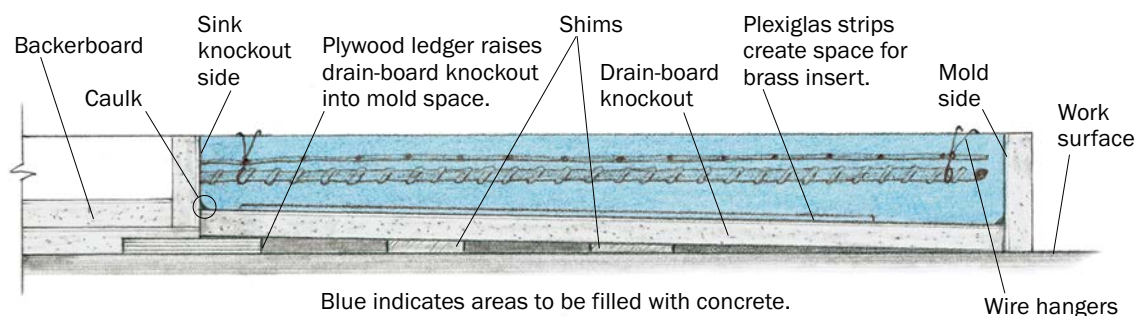
First, the two long sides of the sink knockout are clamped and screwed onto the backboards; then they are screwed onto the mold (see the top drawing on p. 124), tightly registered and square inside the outline of the sink knockout. (The backboards go inside the sink box.) Now the remaining end pieces can be cut to fit, overlapping the ends of the first pair. We use a roundover bit to rout a ¾-in. radius on the square end of

Cross Sections of a Countertop

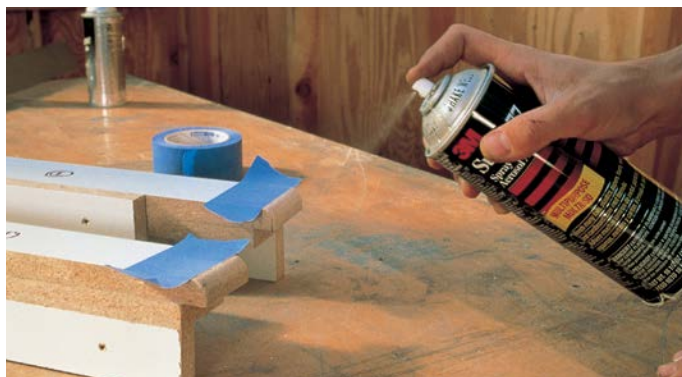
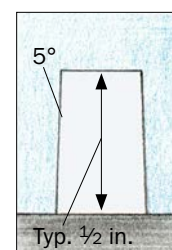
CROSS SECTION A THROUGH THE SINK KNOCKOUT



CROSS SECTION B THROUGH THE DRAIN-BOARD KNOCKOUT



CROSS SECTION OF PLEXIGLAS STRIP



Sealing edges and joints. Sealing the edges creates a smoother concrete finish. After the exposed edges of the sink knockout are coated with spray adhesive (top), the porous substrate is sealed with packing tape (bottom).

each overlapping piece. This curve gives the sink knockout its rounded inside corners.

To seal the exposed substrate on the rounded ends so that they release from the concrete, we mask the melamine face of each piece and coat the ends with spray adhesive, letting it sit for a minute. Then we tape the ends with clear packing tape and trim off the excess (see the photos at left). A bead of silicone caulk is run along the inside edge of the end of each side piece where it butts against the end pieces. We screw the corners together, fill the screw heads, and use alcohol to clean off any caulk that oozes from the joints.

The Mold Sides

There are a couple of ways to attach the sides to the mold. If the mold is deep, we use backerboards for added support, screwing the sides to the backerboards and the backerboards to the table. Backerboards not only give extra support to prevent the sides

from deflecting under the weight of the concrete, but they also make for easy release.

The mold for this countertop was relatively shallow (2½ in.), so we decided it didn't need backboards. Instead, we simply attached the sides to the edge of the mold bottom with countersunk drywall screws spaced about every 6 in. We ran a couple of extra screws into the sides at each corner.

Faucet and Air-Gap Knockouts

If the countertop is thicker than the conventional 1½ in., the mounting hardware probably will need voids. To make knockouts for these voids, we use medium-density fiberboard disks, PVC pipe, sheet foam, and packing tape (see the top photo at right). Because almost all faucets and air gaps are designed for conventional applications, their stems probably won't extend far enough through a thick countertop for mounting washers and nuts. If possible, we have hardware on hand so that we know if the threaded stems are long enough and if we need to size any voids for mounting hardware.

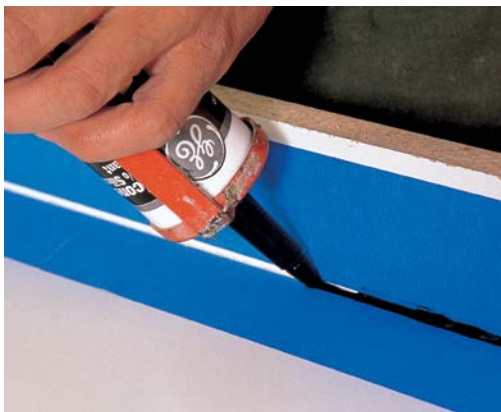
If several penetrations are close together, we make a single large void to accommodate the mounting hardware for all of them. We also make sure there is at least 1¼ in. of concrete between any such void and the edges of the countertop or sink or other knockouts.

Sealing the Mold

If any mold seams leak, water in the wet concrete can leach out, causing discoloration and honeycombing in the finished surface, so we seal the mold with silicone caulk (see the center and bottom photos at right). Strips of tape mask each seam and keep the bead of silicone neat. A moistened finger removes excess caulk and puts a nice concave curve on the caulk, which also gives the finished concrete a slightly eased edge. After the caulk has dried, we peel off the masking tape.



Faucet and air-gap knockouts are made with MDF disks, wrapped with sheet foam and packing tape and screwed down through a short length of 1½-in. PVC pipe.



Silicone caulk seals the mold seams and creates an eased counter edge. Tape defines the area to be caulked (top photo); a moistened finger creates the concave profile (bottom photo).

To caulk around the aluminum channel, first we remove the channel, mask both sides of the kerf and run a bead of silicone into the kerf. Then we push the channel back into the caulk. (We check that the channel sinks completely into the kerf.) When the caulk is dry, we use a razor blade to scrape off excess, and then peel off the masking tape.

Sources

By no means exhaustive, this partial list offers a starting point for those interested in building a concrete countertop.

GENERAL INFORMATION

Portland Cement Association
(847) 966-6200
www.portcement.org

FIBERS

Fibermesh®
(800) 368-2888
www.fibermesh.com

PIGMENTS AND STAINS

Davis Colors
(800) 356-4848
www.daviscolors.com

L. M. Scofield Co.
(800) 720-3000
www.scofield.com

WATER REDUCERS

Master Builders Inc.
(800) 800-9900
www.masterbuilders.com

READY-MADE AD-MIX

Geo-Mix
(contains enough pigment, plasticizer, fast-set additive, and fibers for 3 cu. ft. of concrete)

Cheng DesignSM Products Inc.
(510) 549-2805
www.chengdesign.com



Rebar and remesh. The concrete should be reinforced with $\frac{1}{4}$ -in. or $\frac{3}{8}$ -in. rebar and remesh. Pieces of 1-in.-thick foam insulation serve as spacers that establish the critical distance between the bar and the counter's surface. Remesh can be marked with tape for accurate cuts (left). Tied together, the cage of rebar and remesh is hung from wires attached to the outside of the form (right).

Countertops Need Plenty of Reinforcement

We like to use fibers, $\frac{1}{4}$ -in. or $\frac{3}{8}$ -in. rebar and remesh (4-in. by 4-in. reinforcing mesh) to reinforce the concrete. For this project, we placed a single layer of rebar around the outside edge of the countertop (see the far left photo) and another around the sink knockout; then we tied a sheet of remesh onto the rebar.

We used the template to size the rebar and to position the bends so that the rebar is at least 2 in. from any edge, divide or knock-out. We use more rebar if there's not going to be much support under the countertop or if it has a big overhang.

When the rebar is in the right position, we lay a sheet of remesh over the mold and use masking tape to mark the position of the cuts. When tying remesh to the rebar, we need just enough ties to keep the rebar and remesh cage in position as we pour and vibrate the concrete—say, one tie about every 8 in. to 12 in.

At this point, the cage still can be lifted easily out of the mold in one piece. It's not a bad idea to remove the cage and vacuum the mold. Once the cage is hung in place, the mold will be hard to clean.

To hang the cage, we drive screws into the outside of the mold every 12 in. or so, being careful not to screw through the form (see the left photo above). Thin wire attached to the screws supports the cage. Last, we angle $1\frac{1}{4}$ -in. drywall screws about every 8 in. around the outside edge of the mold into the tabletop, making sure that the mold is still square. Also, we run screws in each of the corners, through the bottom of the mold into the sink knockout (if there is one).

An All-Purpose Concrete Recipe

Although there can be many variations, we at Cheng Design used the following basic mix for the countertop shown. This mix yields 1 cu. ft. of concrete (the countertop shown used 6 cu. ft.); to find the amount you need, multiply the countertop's dimensions to determine its volume and mix accordingly. See Sources on p. 125 for more information.

BASIC DRY MIX

- Type II or III cement: 22.6 lb.
- 37 lb. of $\frac{3}{8}$ -in. pea gravel.
- 72 lb. of sand.

Based on the weight of the concrete, to the dry mix add:

- Sufficient water to create a mix with the consistency of thick oatmeal (6.5 oz. of water per lb. of concrete; the water formula includes the water reducer).

TO INCREASE WORKABILITY

- 8.2 oz. of water reducer (at 12 oz. of reducer per 100 lb. of cement); we use Rheobuild® 3000 FC by Master Builders Inc.

INTEGRAL STAINS

- 8 oz. of carbon black (0.7% of the weight of the cement in a 6.5-sack mix).
- 6 lb. of ultramarine (8% of the weight of the cement in a 6.5-sack mix).

REINFORCEMENT

- Polypropylene fibers (check the fiber manufacturer's recommended ratio).



Shaken, not stirred: the perfect profile.

Once the concrete has been mixed to the consistency of thick oatmeal, it can be placed in the form. Here, two pairs of hands are better than one; while one person fills the form, the other works the concrete into tight places (left). As the form is filled, the mix should be well agitated to ensure that the concrete has flowed into every space on the form. After the concrete has cured, the counter is released from the mold (above).

Pouring the Mix to Fill the Mold

Once the concrete is mixed, it is distributed evenly throughout the form (see the left photo above). This layer is vibrated until it flows evenly over the bottom of the form. There are several vibrating techniques: a pad sander held against the form, a concrete stinger clamped onto the table, or a rubber mallet for rapping the form. The important thing is to make the concrete flow into every crevice. Vibrating also rids the mix of trapped air. Each successive batch must be vibrated.

When the mold is full, we screed the top. After the surface water evaporates, we smooth the surface with a wooden trowel. When the concrete has set up, it can be troweled again and left to cure. Then the countertop must be released from the mold, polished, and installed before it is ready to use.

Fu-Tung Cheng is the author of Concrete Countertops and Concrete at Home, both published by The Taunton Press.

Choosing Kitchen Countertops

■ SCOTT GIBSON

Yearning for the good old days? Take a close look at an old kitchen. Even well-appointed houses were likely to have kitchens that look utilitarian, even stark, when compared with what contemporary cooks expect. Counter space often was provided by a built-in cabinet or dresser with a wood top, or even just a big table. Not these days. We want countertops that delight the eye, stand up to heat, keep out food stains, are easy to clean, and are more durable than the deck of a battleship.

Amazingly, a variety of materials, both natural and man-made, manages to fit the bill: plastic resins, sheet metal, wood, stone, ceramic tile, concrete, even slabs of quarried French lava. Prices range from less than \$5* per sq. ft. for plastic-laminate countertops to \$300* per sq. ft. for granite as rare as blue Brazilian bahai.

In addition to their many practical contributions, countertops also make a big visual and tactile impact. The huge variety of materials—each with its own range of characteristics and cost—allows a kitchen countertop to fit neatly into just about any lifestyle and architectural tradition. Spending thousands of dollars isn't hard to do, but far more economical alternatives also exist. The only trick is wading through all the options.

*Note prices are from 2001.

Scott Gibson is a freelance editor. Cost estimates are gathered from manufacturers, retailers, and installers as well as *Repair & Remodeling Cost Data* by RSMeans. Prices vary by region.

Butcher Block: Built-in Cutting Boards

Butcher block is one of the few totally natural kitchen-countertop materials. Typically made from strips of hard maple, 1½-in.-thick butcher-block counters are glued up to expose wear-resistant edge grain. They can be ordered in sizes up to 12 ft. long and 4 ft. wide for about \$30* to \$35* per sq. ft. Butcher block can be ordered through local lumberyards and home centers as well as a few large manufacturers. One of them, John Boos® & Company, also makes end-grain tops 4 in. thick in sizes up to 60 in. by 38 in. for about \$85* per sq. ft.

Among its advantages as a countertop material: It's easy to work and install, has a visual warmth and pleasing resilience, and can be used as a cutting board. Scratches, scorch marks, and other signs of wear and tear can be counted as character, or scraped and sanded away. One drawback is that wood is susceptible to water damage, so butcher block used around the sink should be carefully sealed.



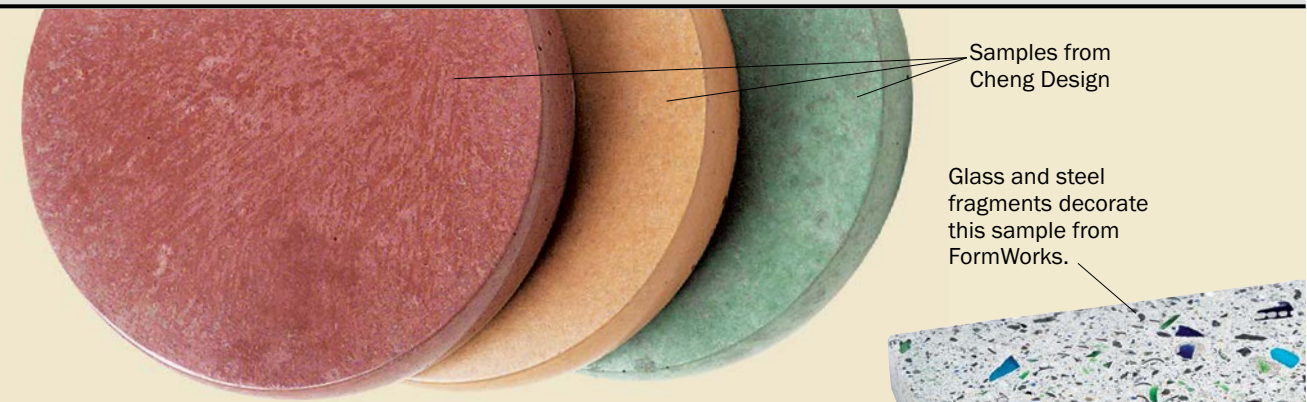
Chop where you like. Maple butcher block exudes a visual warmth many other materials lack (above). Standard thickness is 1½ in., although 4-in. thick end-grain block is available (left).

PROS: Resilient, easy to work, relatively durable, can be used as cutting board, surface can be repaired.

CONS: Will scorch, not as easy to keep clean as some other materials, can stain if unsealed, susceptible to moisture damage around sinks.

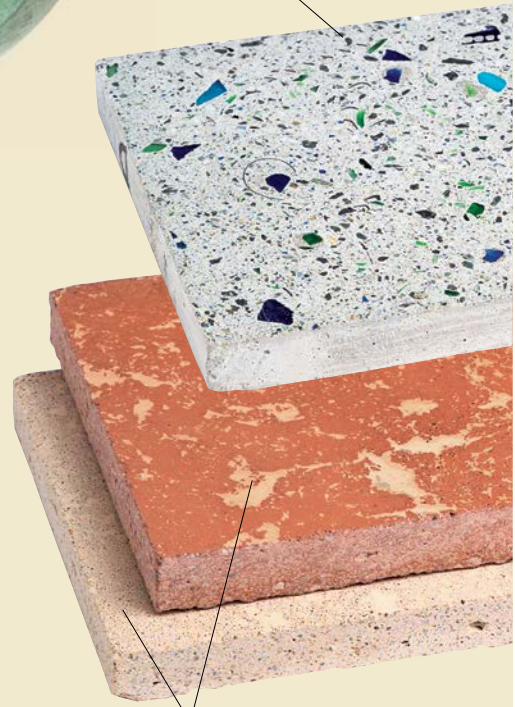
COST: \$30* to \$85* per sq. ft. uninstalled (shipping, if applicable, extra).

Concrete: High Style, Potentially High Maintenance



Samples from
Cheng Design

Glass and steel
fragments decorate
this sample from
FormWorks.



Marbleized patterns
are typical in the work
of Buddy Rhodes.

From a design perspective, few countertop materials are as malleable as concrete. Cast upside down in molds or formed in place, concrete counters can be made in virtually any shape and thickness. Made correctly, they are hard, durable, and heat- and scratch-resistant. But cast without proper reinforcement and the correct mix of materials, concrete counters have been known to develop severe cracks as they cure. Even the best of them will stain if not assiduously maintained.

"Sidewalk contractors who do kitchen countertops may be part of the PR problem," says Jeffrey Girard of FormWorks in Raleigh, N. C. Counter fabricators such as Girard often cast standard countertops 1½ in. to 2 in. thick, using structural steel and polypropylene fibers to minimize cracking.

Fabricators exert considerable control over the look of the finished product. Girard, for instance, adds pieces of glass and metal to the mix, then grinds the surface to create beautiful, multicolored patterns

(see the top photo at right). The work of concrete pioneers like Fu Tung Cheng (see the photo above) and Buddy Rhodes (see the photo at right) further reveal concrete's versatility.

Concrete's Achilles' heel as a countertop is that it stains easily. "The bottom line is that your concrete counter is going to end up staining no matter what you do," says Eric Olsen, a Berkeley, Calif., writer who collaborated with Cheng on a book on the topic. "That's part of its charm."

PROS: Versatile, heat resistant, durable, colors and textures easily customized.

CONS: Can stain.

COST: \$60* to \$75* per sq. ft. for prefabricated countertops (shipping and installation extra).



Site-cast counters are another alternative. Oregon builder Thomas Hughes cast this counter upside down in his client's garage from garden-variety portland cement and aggregates.

Tile: Design Flexibility, Durability, Low Cost

As a countertop material, ceramic tile offers nearly as much design flexibility as concrete. Tile is available in a huge variety of colors, patterns, textures, sizes, and prices, from mass-produced 4-in.-sq. field tile to hand-painted works of art. Installed prices start at about \$15* per sq. ft. for a basic counter and go up from there. Loose field tile starts at less than \$2* per sq. ft.

Glazed ceramic and porcelain tiles have a glass-like outer layer that makes them long-wearing, highly heat resistant, and nonabsorbent. Tile can be set on a mortar bed or over cement backerboard with thinset mortar. Because it is easy to cut, tile can be formed into counters of just about any shape and size. Damaged tiles can be chiseled out of a counter and replaced.

The downside? For one, tile is really hard. Fragile wine glasses and thin china won't fare well in care-less households. You'll need cutting boards on tile surfaces, and because tile counters are made of many pieces, the surface is unlikely to be perfectly flat. Tile's major shortcoming is the grout between the tile. Left untreated, cement-based grout stains easily, and it can be hard to keep clean.

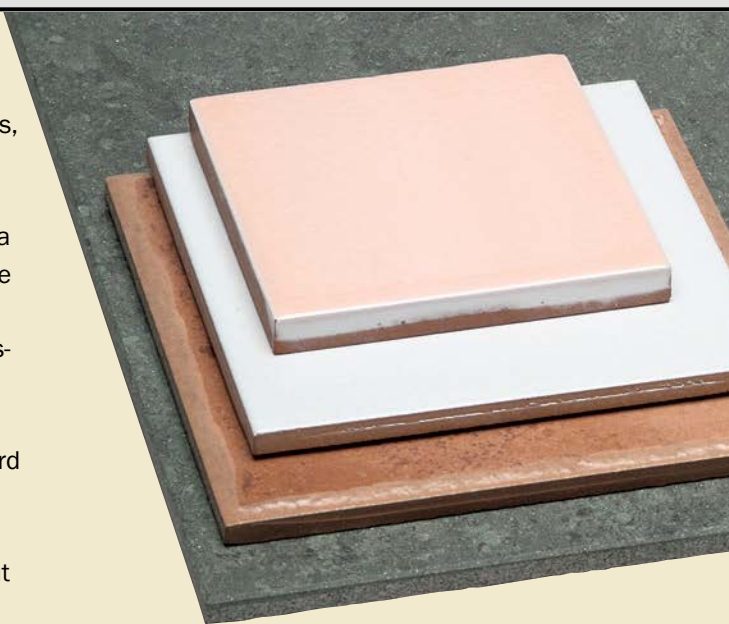
Epoxy grout is one solution. It's good at resisting stains. But epoxy grout yellows with time, especially when exposed to sunlight.

Cement-based grout can be sealed to provide some protection. The National Tile Contractors Association says a water-based acrylic sealer (such as Aqua Mix®, see Sources on p. 139) is less likely than solvent-based sealers to be eroded by household degreasers and cleaners. The bottom line: The smaller the grout joint, the less maintenance you have.

PROS: Versatile, inexpensive, heat resistant, durable, high stain resistance.

CONS: Grout may stain, surface not perfectly flat.

COST: Materials, including substrate, adhesive, and border tile, from \$7* and up per sq. ft. Installation adds \$8* to \$10* per sq. ft.



Hard-wearing and stain resistant. Ceramic tile, available in hundreds of colors and patterns, offers great design flexibility at a relatively low cost. But watch for grout stains.

Solid Surfacing: A 35-Year-Old Wunderkind in the Kitchen



Few products have had more influence in kitchen design in the past 35 years than DuPont®'s Corian®. What was then the world's first solid-surface countertop material now has many rivals. Avonite®, Gibraltar®, Surell®, Pionite®, Swanstone®, and Fountainhead® all are brand names for essentially the same stuff: polyester or acrylic resin plus a mineral filler called ATH, or aluminum trihydrate. Solid surfacing comes in plain colors, patterns that resemble stone and, more recently, translucent versions that are glasslike in appearance.

Regardless of brand, solid surfacing has a long list of attributes that make it a nearly ideal countertop material. Solid surfacing is the same material all the way through. Minor surface blemishes—a scorch mark, for example—can be sanded out. It's nonporous, so it's easy to keep clean. And it's highly stain resistant. Solid surfacing can be fashioned into a sink and then glued to the countertop for a

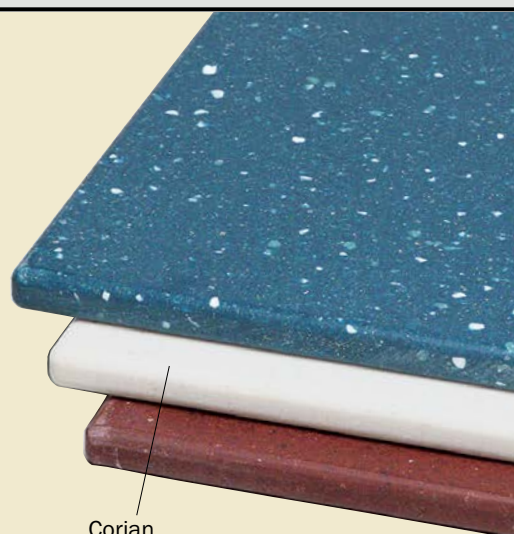
Plastic that looks like stone.

DuPont's Corian revolutionized the countertop world a generation ago, and solid surfacing is still a top choice. It's now made by scores of manufacturers.

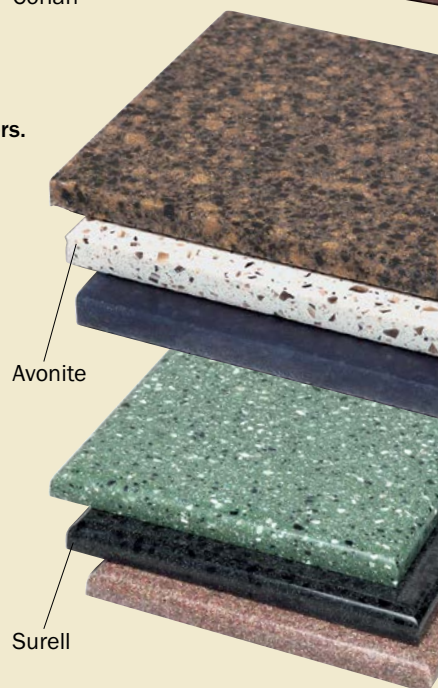
seamless, leakproof installation without any crevices or edges to catch and hold food and debris. It can be worked with regular woodworking tools, and solid surfacing comes with a long guarantee, usually ten years. It's typically sold only to certified fabricators who have taken a manufacturer's training course.

Countertops are most often formed from ½-in.-thick sheets. Edges are formed by building up layers of identical or contrasting material and milling the profile with a router. Sheets 30 in. and 36 in. wide run to 12 ft. in length. Solid surfacing is expensive—roughly \$50* to \$100* per sq. ft.—and it's a plastic, so not as appealing to some homeowners.

PROS: Nonporous and nonstaining, easy to clean, repairable, durable, wide range



Corian



Avonite

Surell

of colors and patterns available, integral sinks possible.

CONS: High cost, should be protected from high heat, sharp knives.

COST: Typically installed by certified fabricator, \$50* to \$100* per sq. ft.

Stainless Steel: The Pros Like It for a Reason



Restaurants like it.

Stainless steel, long a fixture in commercial kitchens, is making gains in residential kitchens for the same reasons: long life and low maintenance.

Once found only in commercial kitchens, stainless-steel counters are gaining ground at home, too. Boston architect Ann Finnerty chose a combination of stainless steel and maple butcher block when she redid her own kitchen four years ago. “I wanted a material that was common and not too precious and not too expensive,” she says. Working with a local fabricator, Finnerty chose stainless steel with a plain edge and no backsplash. Finnerty likes the fact that stainless steel is easy to clean.

“When it’s new especially, fingerprints show up like crazy,” Finnerty says. That problem fades as the surface gets more wear and develops a patina.

Like stone and concrete countertops, stainless steel can’t easily be modified on site. Countertops are usually fabricated from templates, often in 16-ga. material. Sheet metal is glued to a

substrate of medium-density fiberboard. Sinks can be welded in.

Expect to pay \$60* to \$80* per sq. ft. But edge details, sinks and overall complexity can change prices dramatically. Mark Ponder, an estimator at Weiss Sheet Metal, which made Finnerty’s counters, cautions that generalized prices can be misleading. A plain 10-ft. long counter with a simple sink and a 4-in. backsplash might cost \$1,200*, he said—a price that does not include the substrate, shipping or installation. Linda Bergling of The Stainless Steel Kitchen, a large Midwestern fabricator, says her shop charges about \$160* per running foot of counter with backsplash. But the stainless is already laid up on a substrate and ready to go in.

Counters are typically made from 304 stainless with a #4 brushed finish, the same stuff used in restaurants and commercial kitchens. Length is usually

limited to 10 ft., widths to 4 ft., although larger sheets can be ordered. Stainless can be cleaned with a mild detergent or baking soda or vinegar diluted in water, Bergling says, but bleach should be avoided. Some foods—including mustard, mayonnaise, lemon juice, and tomato ketchup—that sit on the counter may cause a white surface discoloration that can be rubbed out with a Scotch-Brite pad.

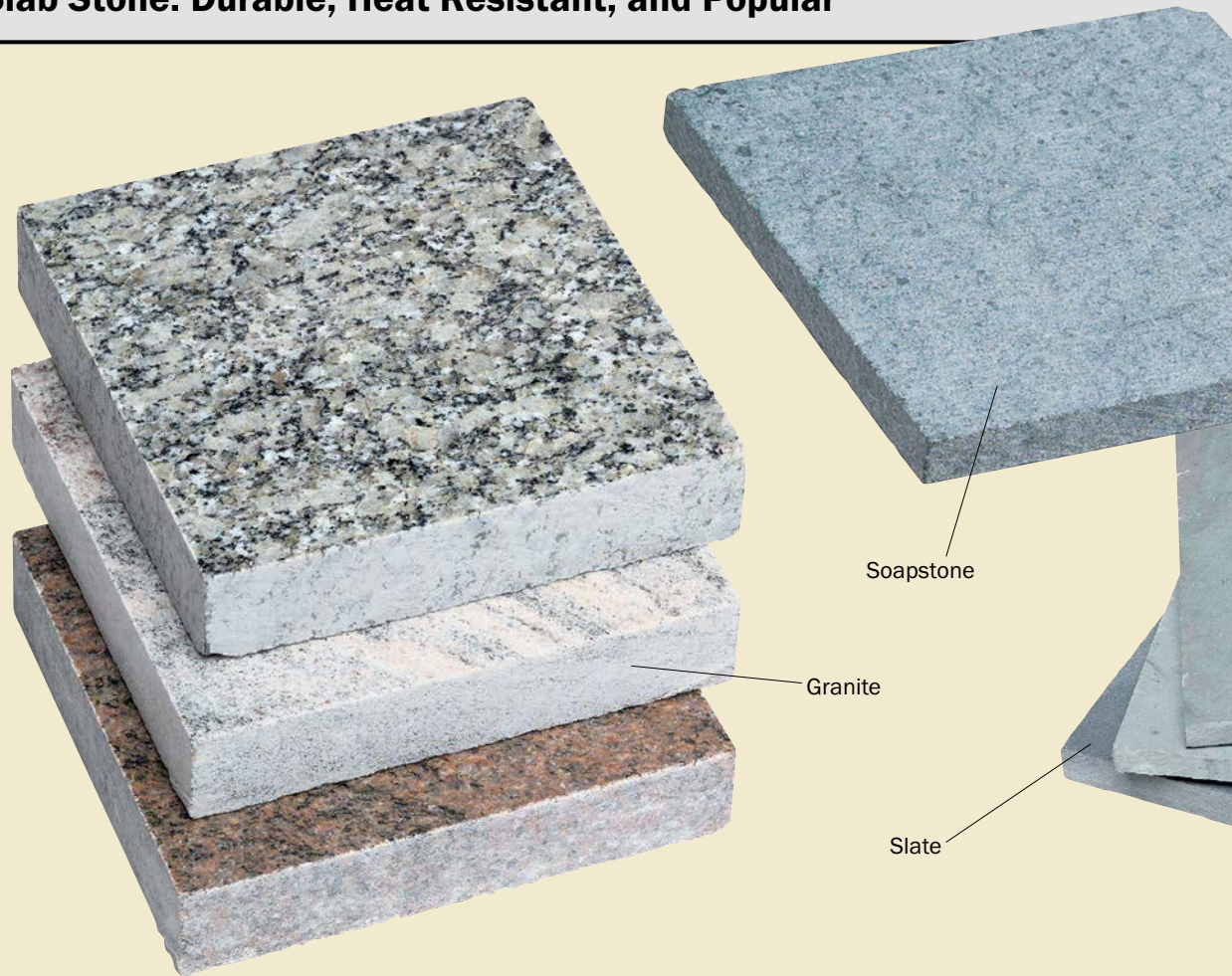
Counters also can be fashioned from copper, zinc, and nickel. But prices are usually higher, and these metals require more maintenance.

PROS: Nonporous and nonstaining, resistant to heat, durable, easy to clean.

CONS: Can dent.

COST: \$45* to \$65* per sq. ft. for uninstalled straight runs; \$80* to \$90* installed.

Slab Stone: Durable, Heat Resistant, and Popular



Slab stone, especially granite, is cold to the touch, heavy, hard to work, and expensive. It's also so popular, says former stone-restoration contractor Fred Hueston, that it's now going into spec houses selling for \$100,000*. "It's the big one now," says Hueston, owner of the National Training Center for Stone and Masonry Trades in Longwood, Fla. Granite comes from all over the world, in a variety of colors and patterns. Prices show big regional differences, starting at \$40* to \$50* per sq. ft. (possibly lower in some areas) and commonly running to \$80* to \$100* per sq. ft. installed.

Sold in two thicknesses ($\frac{3}{4}$ in. and $1\frac{1}{4}$ in.), granite is resistant to heat and scratches. Most countertop material is polished, but it also is available in a honed (matte) finish, usually for a little more money. Slab size is usually limited to 10 ft. in length, 5 ft. in width.

Although resistant to acidic foods such as lemon juice, Hueston says, granite will stain. It's especially susceptible



Pricey but in high demand. Natural stone is the current favorite of high-end countertop choices. It offers high heat resistance and durability and a wide variety of colors and textures, such as this red-slate bar top with a honed finish (bottom photo).



to oil. Penetrating sealers, commonly called impregnators, can keep out oil and water.

Hueston prefers sealers containing fluoropolymers (the same chemical used to make Scotchgard®).

Other stone options include slate and soapstone. Both come in smaller slab sizes than granite (roughly 6 ft. long and between 30 in. and 40 in. wide) and in not nearly the variety of colors. Prices of these two types of stone are similar, \$65* to \$80* per sq. ft., not including installation or shipping.

Blue gray and lightly variegated when newly installed, soapstone oxidizes and darkens with time to a rich charcoal. It is extremely dense, with better stain resistance than granite. But soapstone is also soft. Soapstone is usually treated with mineral oil. Scratches in soapstone can be sanded out.

Slate runs in a wider but still limited color palette: blacks, greens, reds, grays and muted purples. Like soapstone, slate is relatively soft, although scratch marks can be buffed out with fine steel wool, says Daphne Markcrow of Vermont Structural Slate Company in Fair Haven, VT. Vermont slate needs no sealers, she says, and no maintenance, although slate mined in different regions may be more absorptive. Hueston says slate, which is formed in layers, will occasionally delaminate.

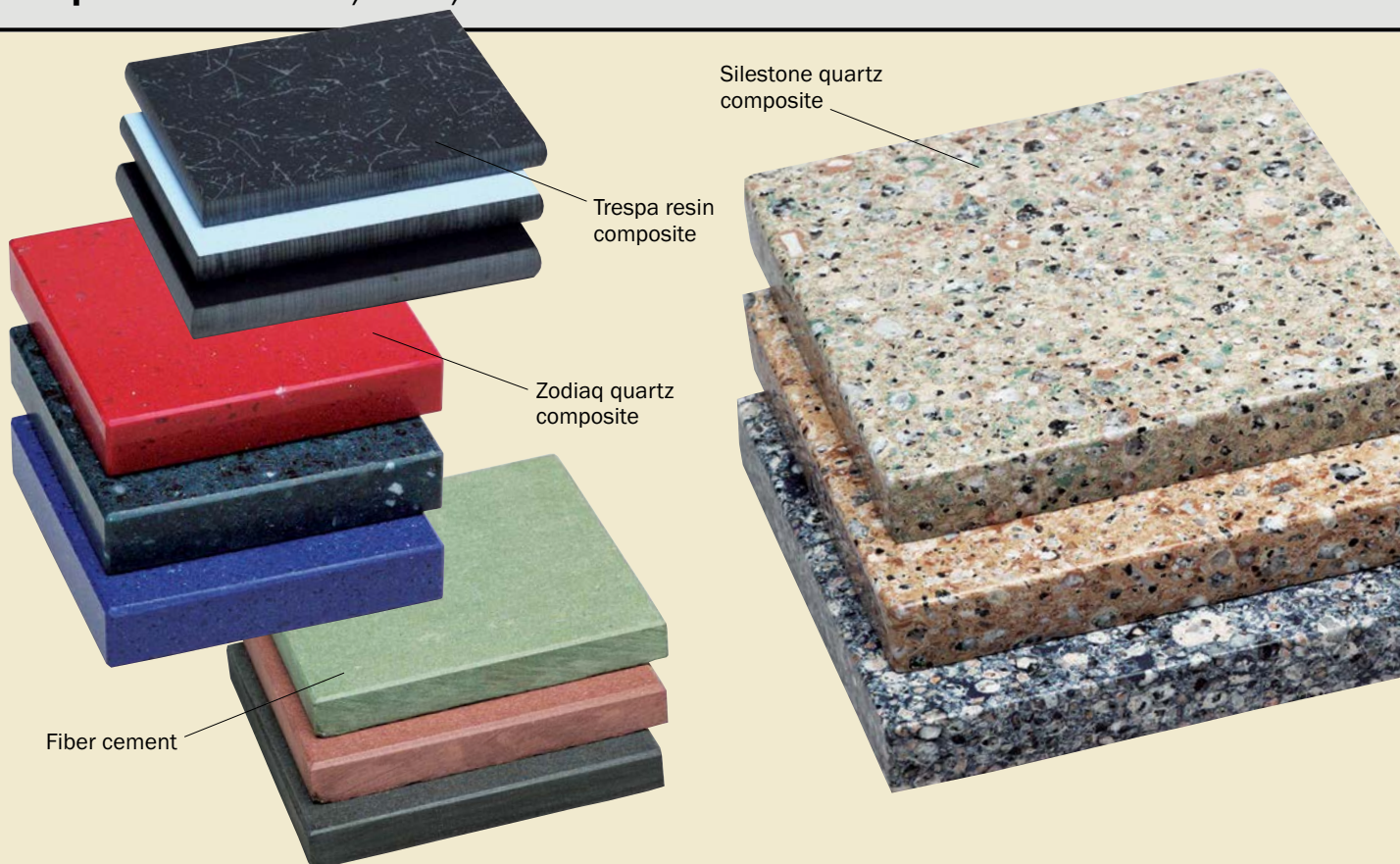
PROS: Wide variety of colors and textures, heat resistant, very durable (stain and scratch resistances vary).

CONS: High cost, some types may stain, slab size may be limited. Can delaminate.

COST: \$50* to \$100+* per sq. ft. fabricated and installed.



Composite Materials, Lava, and Fiber Cement: The New and the Exotic



Although many countertop materials are familiar, a variety of newer, man-made materials also is available.

Silestone is a composite of 93 percent quartz, resin binders and pigments. It is made in Spain and sold in the United States through a network of distributors. A similar material is made by DuPont under the Zodiaq® brand name. Prices vary by region and by the color of the material, but Silestone says that installed prices are between \$45* and \$70* per sq. ft. It is nonporous and never needs to be sealed, the company says, and it's more resistant to food stains than the natural stone it closely resembles. Silestone is available in 35 colors and three thicknesses— $\frac{7}{16}$ in., $\frac{13}{16}$ in. and $1\frac{1}{8}$ in.

Trespa® is a Netherlands-based company that makes three types of composite architectural panels. Two of them—TopLab® and Athlon®—are potential kitchen countertops. Athlon is essentially super-thick high-pressure laminate. It's made from phenolic resins reinforced with cellulose fiber and manufactured

under high pressure and temperature. Its top decorative layer is melamine-impregnated paper, and it is available with either a smooth or slightly textured finish. Standard sheet sizes go up to 6 ft. by 12 ft., with thicknesses ranging from $\frac{1}{4}$ in. to 1 in. One thing that makes Athlon attractive is its price: In a $\frac{1}{2}$ -in. thickness, Athlon is less than \$7* per sq. ft. It can be worked with standard carbide tools, and it doesn't need sealing. TopLab is usually used in laboratory settings because of its resistance to chemicals, scratches, and stains. Prices are slightly higher. Pionite makes a similar material called thick phenolic-core laminate.

In the market for something truly unusual? How about French lava with a kiln-fired enamel coating that the manufacturer says is impervious to stains and heat? Pyrolave comes in sheets up to 4 ft. by 8 ft., in two thicknesses— $1\frac{1}{4}$ in. and $1\frac{1}{2}$ in. Custom colors are available in addition to the 30 stock colors the company offers. Installed prices range from \$220* to \$350* per sq. ft.



Ooh la la! Ancient French lava from Pyrolave is an expensive and alluring countertop choice. Other nonstandard choices are quartz composites, resin composites, and fiber cement.

Fiber-cement countertops—sold under the SlateScape®, Fireslate2, and Colorlith® brand names—are manufactured in Germany, imported to the United States, and sold through authorized fabricators. Fiber cement has the bulk of quarried stone, but it can be less expensive: \$30* to \$40* per sq. ft. in 1¼-in. thickness. Fiber cement is currently available in four colors and five thicknesses. It has good resistance to heat and has high compressive strength. Like other cement-based products, this material stains easily unless it is sealed properly—and that takes regular maintenance. The company suggests pure tung oil two or three times a year to augment the penetrating sealer applied by the fabricator.

QUARTZ COMPOSITES

PROS: Nonporous and nonstaining, scratch and heat resistant, durable.

CONS: Relatively high cost.

COST: \$45* to \$75+* per sq. ft. installed.

RESIN COMPOSITES

PROS: Scratch and stain resistant, low cost.

CONS: Limited color choice, damaged by heat.

COST: \$7* to \$10* per sq. ft.

FIBER CEMENT

PROS: Relatively low cost, heat resistant, durable, high strength.

CONS: Can stain (requires periodic resealing), limited color selection.

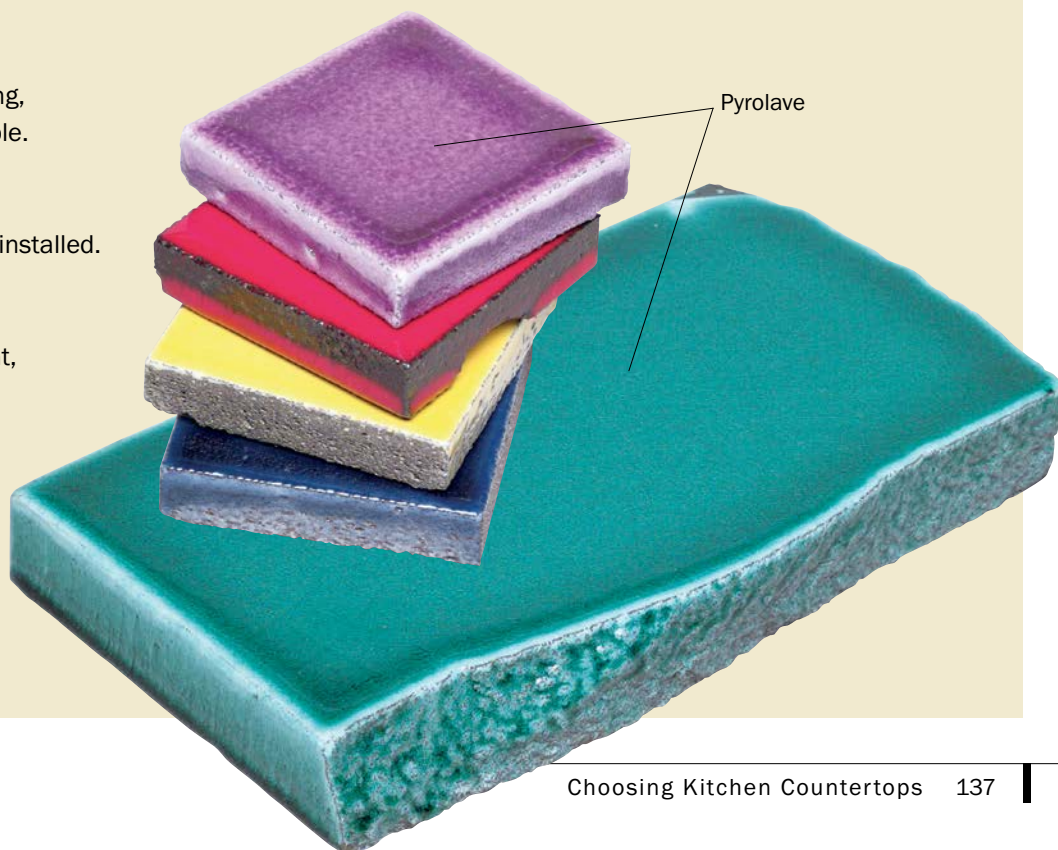
COST: \$30* to \$70* per sq. ft. uninstalled (shipping extra).

LAVA

PROS: Hard, stain resistant, heatproof.

CONS: Extremely high cost, limited availability.

COST: \$220* to \$350* per sq. ft. (installed).



Plastic Laminate: Old Standby Still Rules



An array of Wilsonart patterns

High-pressure laminate is the family minivan of the countertop world: It's practical and economical, and you'll never brag you own it. Still, laminate is the choice in as many as three-quarters of all new kitchens in the United States. Standard high-pressure laminate, roughly $\frac{1}{16}$ in. thick, is a sandwich of kraft paper impregnated with phenolic resin and topped by a decorative layer of melamine-protected paper. In sheet form, laminate is glued to a particleboard substrate, either on site or in a fabricator's shop. A thinner version is manufactured into a ready-made countertop with a rounded front edge and an integral backsplash called a post-formed counter.

Laminate is available in dozens of colors and patterns for \$2* or less per sq. ft. in sheets up to 12 ft. long and 5 ft. wide. Post-formed counters, ready to drop

into place, may be \$5* or less per sq. ft. at big home centers. There are fewer colors to choose from, and post-formed counters are for straight runs only; curvaceous kitchen designs won't work.

Most kitchen countertops are made of general-purpose laminate, but laminate is also available in high-wear, extra-thick, and fire-retardant versions. In addition to its low cost, laminate has many other attributes. Hard and durable, laminate is highly stain resistant and stands up well to everyday use. However, heat and sharp knives damage the surface, and any water getting into seams may degrade the substrate.

A variety of new edge treatments has eliminated one of laminate's long-standing aesthetic weaknesses: the dark line formed where the top of the counter meets the front edge. Edging made from wood, solid-surface material, or beveled laminate can

make that seam all but invisible but at a higher cost.

Laminate's real breakthrough in recent years has been in the top decorative layer. Digital printing and metallic inks have resulted in higher-fidelity reproduction, allowing manufacturers to create uncannily accurate patterns of materials such as wood, stone, and fabric.

PROS: Inexpensive, relatively durable, easy to clean, needs no regular maintenance, wide range of colors and patterns available.

CONS: Damaged by sharp objects and heat, not repairable.

COST: Uninstalled post-formed counters, \$5* per sq. ft., \$1.50* per sq. ft. for sheet laminate. Installed, \$8* to \$11* for post-formed, \$10* to \$17* for laminate sheet.



The workhorse. Today's high-pressure laminate is aided by innovations in digital printing.

Sources

BUTCHER-BLOCK SOURCES

John Boos & Co.
(217) 347-7701
www.johnboos.com

The Hardwood Lumber Co.
(800) 798-1269
www.hardwood-lumber.com

CONCRETE SOURCES

Cheng Design
(510) 849-3272
www.chengdesign.com

FormWorks
(919) 434-5339
www.formworks-nc.com

Buddy Rhodes Studio Inc.
(877) 706-5303
www.buddyrhodes.com

TILE AND INSTALLATION SOURCES

**National Tile Contractors
Association**
(601) 939-2071
www.tile-assn.com

Tile Council of America
(864) 646-8453
www.tileusa.com

Aqua Mix
(800) 366-6877
www.aquamix.com

For a list of tile manufacturers
and distributors, www.infotile.com

HIGH-PRESSURE LAMINATE/SOLID- SURFACE SOURCES

Avonite
(800) 428-6648
www.avonite.com

Corian
(800) 426-7426
www.corian.com

Gibraltar
(800) 433-3222
www.wilsonart.com

Pionite
(800) 746-6483
www.pionitesolid.com

Surell, Fountainhead
(800) 367-6422
www.formica.com

Swanstone
(800) 325-7008
www.theswancorp.com

SLAB-STONE SOURCES

**Freshwater Stone +
Brickwork**
(207) 469-6331
www.freshwaterstone.com

**Vermont Structural
Slate Co.**
(800) 343-1900
www.vermontstructuralslate.com

Vermont Soapstone Co.
(800) 284-5404
www.vermontsoapstone.com

STAINLESS STEEL SOURCES

**The Stainless Steel
Kitchen**
(800) 275-1250
www.stainlesssteelkitchen.com

GMS
(800) 787-3247

RESIN-COMPOSITE SOURCES

**Trespa North America
Ltd.**
(800) 487-3772
www.trespanorthamerica.com

FIBER-CEMENT SOURCES

**American Fiber Cement
Corp.**
(800) 688-8677
www.americanfibercement.com

QUARTZ-COMPOSITE SOURCES

Silestone
(800) 291-1311
www.silestoneusa.com

DuPont Zodiaq
(877) 229-3935
www.zodiaq.com

KILN-FIRED LAVA SOURCES

Pyrolave
(919) 788-8953
www.pyrolave.com

PLASTIC-LAMINATE SOURCES

See manufacturers listed for
solid surfacing, at left.

Making a Solid-Surface Countertop

■ SVEN HANSON



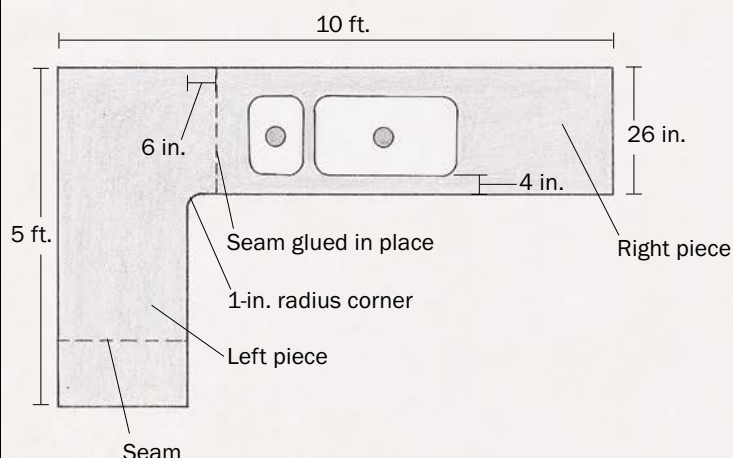
Twenty years ago DuPont introduced Corian, the first solid-surface countertop material, to the building community. It was received with a chorus of yawns. On the one hand, it looked like stone but wasn't the real thing. On the other, it resembled plastic laminate while costing three to four times more money.

But this neither fish-nor-fowl quality of the material doesn't tell the whole story. The most desirable aspects of solid-surface material are its workability and durability. Unlike laminate, the color and pattern of solid-surface countertops go all the way through the material, which means it lasts longer and can be repaired easily. The material is almost as dense as stone—in the range of 100 lb. per cu. ft. But unlike stone, it can be glued up with imperceptible seams and cut and shaped with carbide woodworking tools. And as more colors and patterns have come on the market, the once-reluctant public has embraced solid-surface countertops in a big way.

Finishing up. Once sanded and buffed, the seam (left of sink) is nearly invisible.

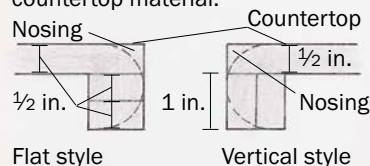
Decide Efficient Way to Use Material

Seams, edges, and corners. Like plywood, solid-surface material comes in wide panels that have to be ripped to the correct width. But unlike plywood, they can be assembled with nearly invisible seams. To build the L-shaped counter shown below, the author used three pieces. Because the counter was too unwieldy to preassemble, he made it in two sections that were then assembled on site.



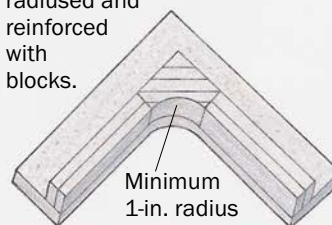
BUILT-UP NOSING

The thick, rounded nosing of a solid-surface countertop is built up from 1/2-in.-thick strips of the countertop material.



INSIDE CORNER BLOCK

Inside corners are radiused and reinforced with blocks.



Corian, which is made of acrylic plastic mixed with a powdered clay filler called aluminum trihydrate (ATH), now has competition. Other brands of solid-surface material, such as Avonite, Surell, and Gibraltar (see Sources on p. 151), are made of polyester resin and the same ATH filler and color-fast pigments. The working properties of the materials, however, are the same. And even the distributors say that, once installed, the main difference between brands is pattern.

All of the manufacturers offer seminars on working with their material, and you typically need to take a course before you can buy the goods. That's because manufacturers are understandably nervous about bad fabrication practices infecting the reputation of their products.

When I started building solid-surface kitchens, I liked the patterns and colors of Avonite's materials. So three years ago I took their one-day certification class. It cost \$50*, most of which I made back in doughnuts, soft drinks, and router tricks.

Since that introduction to the material, I've made a lot of kitchen counters and lava-tory tops, and I've taken Avonite's advanced class. I've found the material to be surprisingly workable, and mistakes are pretty easy to fix, which is no small consideration when the material costs \$15* per sq. ft. and up. This chapter is about the basics, and I'll focus on a typical kitchen counter to illustrate the tools and the techniques for working solid-surface materials.

Start at the Corner

Most counters have a dogleg in them where they turn a 90-degree inside corner—at least it looks like a 90-degree corner. Veteran installers have learned the hard way always to check for square and to adjust according to what's really there because solid-surface counters are tough to trim in the field.

If the counter's shape is complicated, I make a full-size template. I prefer 1/2-in.

medium-density fiberboard (MDF) for template material, but cardboard will do in a pinch. If you use cardboard, though, and need to collapse the template for transport, cut it into segments with a chevron or zigzag pattern; don't fold it. The segments can be reassembled only one way and won't lose the ¼ in. or more of length that folding can cause. If I'm replacing an old countertop, I sometimes use it as a template.

I start a job back in the shop by deciding the most efficient way to use the materials. Economy, maneuverability, and color matching all are important. For example, the project illustrated here had a 10-ft.-long counter intersected by a shorter countertop (see the drawing on p. 141). Avonite sheets are ½ in. or ¾ in. thick and come in 5-ft. or 10-ft. lengths that are either 30 in. or 36 in. wide. For a minimum order of 25 sheets, you can get ¼-in.-thick material. I use ½-in. material for counters because it costs 30 percent less than ¾-in.-thick stock. When supported every 18 in., it's plenty strong, and adding a built-up edge, or nosing, can easily make ½-in.-thick material look as though it's 1½ in. thick.

I bought a 10-footer and a 5-footer for this job, both 36 in. wide. The extra width costs more but gives me matching material for backsplashes and built-up edges. I cut down the 10-ft. sheet to 85 in. (the right

piece) and glued part of its offcut onto the 5-ft. sheet (the left piece) to make it the correct length. This way I made two manageable pieces by making an extra seam. I later joined the two pieces in place, making one L-shaped counter, but I'm getting ahead of the story.

Before making any cuts, I studied the color and pattern of the two sheets. Each batch of material is slightly different, so it's important to get sheets from the same run if they are going to be joined together. The pattern can even change from one end of the sheet to the other.

Ripping with Cornstarch

This counter is 26 in. wide, and with my first cut I ripped the 10-ft. piece down to 26½ in. (see the photo below). Then I removed ½ in. from the other side to get rid of the factory edge, which is usually a bit rounded and sometimes chipped. Rather than fuss with the factory edge, I've found it more efficient just to eliminate it.

To minimize scratching, I saw the sheets face up, with a blade specially made for solid-surface materials (Golden Eagle Model G1060S, DML, 1350 So. 15th St., Louisville, Ky. 40210; 800-242-7003). The blade's teeth have equally beveled top corners, resembling little coffins (this tooth configuration is called a triple-chip grind, or TCG). It makes a nearly chip-free cut on both top and bottom surfaces and works equally well on other plastics.

To help slide the unwieldy sheets across the saw, I dust the top of the table with cornstarch. Cornstarch is cheap, available, biodegradable, and won't contaminate the saw or the material.

Next I lopped off the 10-ft. sheet to get a piece 85 in. long. I used a circular saw to make the rough cut, then jointed the edges with a router to get rid of the saw marks because each line in a saw kerf is a potential starting point for a stress-induced crack.

Cutting down to size. Solid-surface materials come in big sheets that have to be ripped to width using a table saw with a special solid-surface blade. Sprinkling the saw's table with cornstarch makes it easier to slide the sheet. A dust mask is essential for working the material.





Cutting guide. Inside corners have to be radiused to reduce stress. This MDF cutting guide has a radiused wood insert at its corner.



Collar and bit. A metal sleeve called a collar, or template guide, rides along the edge of the cutting guide and separates the guide from the 1/2-in. straight-flute bit.

Leaving the tooth marks voids the warranty on the material. By the way, you shouldn't cut solid-surface material with a jigsaw. Its up-and-down action can cause fractures.

Note in the plan drawing of the counter that the inside corner is radiused (minimum 1 in.) and that the seam is 6 in. from the corner. These two details, which help relieve stress at the corner, require the left piece of the counter to look a little like an L. To cut the piece, I used a shop-built cutting guide (see the left photo above) that steers the router down the counter, around the corner, and off the narrow end where the joint will go. I use a 1/2-in.-dia., two-flute bit to make this cut. A 3/4-in. collar, or template guide, affixed to the router's base rides against the cutting guide (see the right photo above).

Solid-surface materials put heavy loads on a router and the bit. Manufacturers of solid-surface materials recommend 3-hp routers and bits with 1/2-in. shanks. I use the recommended 1/2-in. shanked bits, but my 1 1/2-hp router has proved to be plenty powerful.

Joining Two Pieces

Inconspicuous seams between mating pieces are easy to make if the pieces fit together tightly. And the key to tight seams is the mirror jig (see the left photo on p. 144). My version is a 12-in. by 48-in. by 3/4-in. scrap of veneered particleboard with a 3/4-in. by 40-in. slot down the middle. I clamp abutting sections of counter to the jig, with their leading edges in correct alignment, so that my router bit cuts both their mating edges simultaneously. I support the pieces during the cut on a couple of 2x4s laid flat across a pair of sawhorses.

When I dry-fit pieces together, two tests determine a good seam. If a line can't be seen easily, I'm ready. If I see a gap, but the corner of a dollar bill won't fit into it, I'm still ready; otherwise, I must lightly recut the joint.

Before joining the pieces, I lay out marks for #20 clear plastic biscuit splines. Avonite is the only company I know of that requires them, but I use the biscuits no matter which



Mirror jig. A slot down the center of the mirror jig guides the router's collar as abutting pieces of counter are jointed simultaneously.

brand of material I'm working with because the biscuits help align mating pieces. I place one 3 in. from each edge and add a third in the middle.

Using a square sanding block with 120-grit PSA (pressure-sensitive adhesive) sandpaper stuck to it, I give the edge, the top, and the underside of the seam two firm swipes each (see the right photo above). The possibilities of rounding the corners are outweighed by the probability that I'll knock down some extra plastic that might have held the seam open. Finally, I clean each edge and biscuit slot with a dust-free, colorless rag soaked with denatured alcohol.

Glue Up

Before I mix a glue batch, I use hot-melt glue to attach 1x1 scraps to the face of the sheets on both sides of the seams about ½ in. from the edge. The scraps will supply clamping points for spring clamps. I use a medium-strength (clear or milky white) hot-melt



Edge treatment. Prior to glue up, mating edges are cleaned up with a sanding block. This block is made with a sticky-backed disk stuck to a hunk of plywood.

glue, which can take plenty of spring-clamp pressure but can be peeled off without pulling up chips. The glue will usually lift away easily from the counter. If it needs coaxing, I pour some denatured alcohol on it and pry it off with a wide chisel.

Solid-surface glues come in two speeds: fast and slow. Both require a catalyst, and both have to be liquid to make a good seam. The fast glue has a pot life of about seven to 10 minutes before it turns to marmalade. The glued-up pieces are ready to work in about an hour. Slow glue has a slightly longer pot life of about 12 minutes, and pieces glued up with slow glue are ready to work in about eight hours.

The slow glue is a lot less expensive than the fast stuff. It's also more relaxing to use. I typically prepare all the pieces that need gluing, mix a big batch at the end of the day, assemble the parts, and let them cure overnight.

Fast glues are available in different colors; you should use the one that matches the



Plastic biscuits. Butt seams between mating pieces are aligned and strengthened with biscuit joints. Note the gray glue, custom mixed to match the material.

material at hand. For slow glues, I keep a range of Avonite glue pigments around so that I can mix colors as necessary. I go easy on the pigments because glues should be translucent, not opaque.

When I've got the color right, I stir in the recommended amount of catalyst. I've found that adding more catalyst just decreases the pot life of the glue without speeding the cure time.

Using a 1/8-in. bronze brazing rod, I shove glue into the biscuit slots and spread it along the edges. (I use brazing rods because they fit, and I have them handy.) Then I dunk the clear plastic biscuits (no wood, please) and stuff them into the slots (see the left photo above).

With the pieces on my 2x4 workbench, top-side up, I push them together within 1/8 in. and pour the rest of the glue into the gap. Then I align the front and back edges and apply the spring clamps to the clamping blocks every couple of inches. I should see a continuous bead of squeeze-out (see the photos at right). Like epoxies, these glues must have dimension. Too much pressure will cause a glue-starved seam, so spring



Fill, then clamp. During glue up, adjoining pieces are kept 1/8 in. apart while glue is drizzled into the gap. Then the pieces are put together, and spring clamps are applied on 3-in. centers to the 1x clamping blocks.

Ski time. Cured glue squeeze-out is cut away with a straight-flute bit and a router riding on slippery tracks, such as these bronze brazing rods. The process is called skiing.



clamps are the right choice for the job: They don't clamp so tightly as to squeeze out all of the glue. I let the squeeze-out cure rather than trying to remove it while it's still soft. Premature removal can lift the glue out of the joint.

I remove the cured squeeze-out with the router (see the photo above). Called skiing, this method requires a router with a straight bit and a couple of thin runners for the router to ride on (I use bronze brazing rods).

When I've removed the glue from the bottom of the counter, I glue a seam block over the seam. Seam blocks are 4-in.-wide strips of the counter material that run the depth of the counter, minus any built-up edges.

Rounded Edges and Corner Blocks

A thick, rounded nosing on a solid-surface countertop gives the counter visual weight. To make the nosing, I rip two 1-in.-wide strips of edging stock from the cutoffs. Then with my sandpaper block, I lightly sand all faces, edges, and ends of the strips.

There are two ways to apply the edging. The best way is the vertical style (see the right drawing on p. 141), but it requires very straight strips and smooth edges. If your table saw isn't up to that kind of a cut, the

horizontal, or flat, built-up style will work better. I avoid the flat technique because it requires more glue, it squishes out of alignment when clamp pressure is applied, and it's more likely to have gaps between layers.

It's easier to adhere the edges with the counter upside down because you can see what's happening, and the glue stays in place. I mix my glue, squeeze a bead along the edge of the outside strip, and clamp it in place. The strip should be either flush with the counter or slightly recessed—about $\frac{1}{32}$ in. An army of spring clamps on 3-in. centers applies the correct pressure. The second layer gets clamped to the first (see the top photo at right). At inside corners, the edging butts into reinforcing blocks.

After the glue cures, I run my router against my inside corner guide to trim off any squeeze-out. Then I use the roundover bit to put the bullnose on the edging. I run the wide Lexan® base of my big router on edging strips (lubed with cornstarch) to keep the bit steady and square to the work (see the bottom photo at right).

As I mill the bullnose, I stop the router short of any butt joints that are still to come. This guarantees that I won't have a dip in the nosing caused by an inadvertent back cut. Before I flip the counter right-side up for bullnosing, I smooth the edge with my random-orbit sander running a disk of 60-micron paper.

After rounding over the top side in the same way as the bottom, I'm ready for some serious sanding. Although they are sanded at the factory, the sheets still need to be buffed out. I start with 60-micron paper. I squirt some water and a few drops of liquid detergent onto the surface. This trick lets the paper cut faster, keeps the disk clean, and suppresses dust (see the photo on p. 148).



Clampfest. Built-up edges, or nosings, are formed out of two strips of Avonite. Here, a vertical strip is clamped to the counter's edge. Then a second strip is glued to its back.



Bullnosing. As he rounds the inside corner, the author supports the router's custom base on edging strips. A dusting of cornstarch greases the track.



Swirling toward the finish. Random-orbit sanding with 60-micron paper followed by 30-micron paper brings out the color and depth of solid-surface materials. A slurry of water with a few drops of liquid detergent speeds cutting and keeps down the dust.

The Sink Top

Forget about those stupid little clips that come with some sinks to affix them to their counters. Solid-surface sinks are glued in place and become one with their work surface. I stuck two sinks under this counter.

To make sure the sinks ended up where I wanted them to, I made ¼-in. plywood templates that represented the sinks' outside perimeters and drain holes. I put the templates under the kitchen window and moved them back and forth until I liked the positioning. Then I noted the distance from the wall to the edge of the template.

I put the sink counter upside down on my 2x4 workbench. Then I transferred the sink measurements to the counter and marked the outlines of the templates with a pencil. The sinks are set back 4 in. from the front edge.

I drilled 1-in. holes in the countertop that correspond with the drain holes in the sinks (see the top left photo on the facing page). Then I mixed another batch of glue for the sinks. Once I had the glue spread and the sinks in place, I ran pipe clamps through the holes to exert some pressure on the assembly. Hand screws and spring clamps provided the rest of the clamping action (see the top right photo on the facing page).

When the glue on the sinks cured, my colleague, Ed Schairer, and I gingerly flipped the still-tender, but very heavy, assembly and rested it on the 2x4s standing on edge. Then I got out my 2-in. by ½-in. flush-trimmer bit to remove the sink cutouts from the counter. I checked the bit's bearing to make sure it was firmly attached (you don't want it falling off during this operation), and I wrapped some vinyl tape around the bearing to keep it from marring the sink's surface.

From center hole I take the shortest route to the sink edge (see the bottom photo on the facing page). With the bearing pressed firmly to the side of sink, I cut clockwise. At the 3 o'clock and 9 o'clock positions, I stuck Avonite blocks with hot-melt glue to



Gluing the sinks. After drilling holes in the counter for pipe clamps, the author runs a bead of fast-set glue along the flange of the sink. The wood strip at its base will align the outer edge of the sink during glue up.



Clamping the sinks. A pipe clamp through each drain hole applies pressure. Wood blocks protect the sinks from the clamps, and the pressure must be light. Assorted other clamps hold down the edges to get even squeeze-out.



Cutting out the sinks. The pipe-clamp hole becomes the starting point for cutting out the sink tops with a bearing-guided straight bit. The little blocks of Avonite were affixed with hot-melt glue to keep the cutouts from falling into the sinks.

the sink cutouts. The blocks kept the cutouts from falling into the sinks as I finished the cuts. I used my roundover bit to radius the counter edge where it turns down into the sink, and I smoothed the transition with a random-orbit sander.

Counter Support

Solid-surface counters must be mounted on a lattice-type grid of supports 18-in. o. c. because plastics are natural insulators. A heat source like a toaster or electric frying pan will cause heat buildup, localized expansion, and stress. If the counter sits atop a solid base, such as a sheet of plywood, it won't get enough airflow around it to dissipate the heat. Solid substrates must be cut out to meet warranty requirements.

The old cabinets under this new counter needed a few 1x4s added on the flat to satisfy the warranty requirements. The rule

book also calls for continuous support under seams, so I put another 1x4 to the left of the sinks. I put vinyl tape on top of this support because a glued-in-place seam is above it. The glue does not stick to the tape. So the tape ensures that the top is not accidentally glued to the 1x4 support, which could eventually cause a crack to open up.

The supports also serve as anchorage for the counter. Thumb-size dabs of silicone caulk 18-in. o. c. are recommended. The counter squashes the dabs, making flat pads of stickum that can flex a little with the counter. If you've got a one-piece counter, you can put the dabs down before you place the counter. This two-piece job called for a more complicated approach.

Gluing in Place

Ed and I wrangled the two counter pieces into position and dry-fit them to make sure the butt joint fit well. There is a ½-in. gap at both ends of the 10-ft. section between the wall and the counter. A backsplash typically hides the gap. For this job the slot in the brick veneer conceals it. The gap gave us enough room to slide the two pieces back a bit, then prop them up like a drawbridge.

I used hot-melt glue to stick clamping strips onto the sections. Then I mixed a batch of fast-set glue while Ed squeezed the silicone dabs onto the 1x4 supports. I dunked the biscuits in the glue, popped them in their slots, and spread a bead of glue along the mating edges. Ed and I slowly lowered both counter sections, slipping the biscuits into the second section. I pulled the joint to within ⅛ in. and poured the rest of the glue into the gap. With front edges aligned, I jiggled the two sections together and applied the spring clamps (see the photo at left).

An hour later I skied down the joint to clean up the squeeze-out. Then I went against the manufacturer's recommendations and lightly sanded with the belt sander because the right piece of the countertop

It all comes together.
When the top has been sanded and buffed out, the two legs of the counter are joined in place atop the cabinets. Here the author checks the joint for closure.



was a good deal higher than the left piece at the front edge. Avonite technologists think the unequal heating of belt sanding can cause stress damage to the seam, but two other manufacturers permit belt sanding, and I'm convinced that with a sharp belt and light touch to keep the material cool, there will be no problems. After applying water and detergent, I sanded the surrounding area and then touched it up with a Scotch-Brite pad.

Manufacturers want to steer fabricator and homeowner to a 60-micron finish followed by a buffing with a Scotch-Brite pad. The resulting flat finish is easy to maintain and doesn't reveal flaws. It also doesn't reveal the beautiful depth in many of the patterns. My compromise is to put a little extra polish on with the 30-micron paper to make a punchier impression at the homeowner's first viewing, then knock it back a bit with a light buzzing with Scotch-Brite on the random-orbit sander.

Faucet cutouts are best done with a jig and a plunge router wearing a collar. But my client hadn't yet selected the faucet by the time I had to install the counter. Because there wasn't room to fit the router behind the sink once the counter was installed, I used a drill with a sharp spade bit to make the hole. Then I sanded out the drill kerfs with a little drill-mounted drum sander.

Backsplash

The client didn't want a backsplash for this job, but many situations will require it. For example, heavy-use areas such as sinks ought to have one. A backsplash keeps water from getting behind the countertop and makes the job look finished. It also offers a bonus to installers by giving them a gap of up to ½ in. along the wall for fitting the counter. Here's how I made a backsplash for another installation.

With a long straightedge as a guide, I use a router to joint enough material for the job, then I rip it to width. I precut it to fit exactly



Splash. Counter backsplashes are attached to the wall with silicone caulk and hot-melt glue. The hot-melt glue holds the backsplash in place while the caulk sets up.

and then mark the butt joints onto their related pieces. Then I round over the top edge, stopping the router at the butt-joint mark.

When I like the fit, I put a fine bead of silicone caulk down the underside and arbitrarily place dabs of silicone on the back (see the photo above). Placed among them, typically at large gaps between the backsplash and the wall, I put globs of hot-melt glue. Within a minute of pressing a backsplash (down and in simultaneously), it is firmly stuck. If temperature changes move the backsplash, it can break the hot-melt glue bond and hang there with the flexible silicone.

If the wall is curved a bit, I place the backsplash piece in the sun. When the piece warms up, I flex it to the desired shape. Let cool. Install.

*Note prices are from 1993.

Sven Hanson is a woodworker in Albuquerque, New Mexico.

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INDEX

A

Alexander, Rex, 26–35, 90–97, 98–105
 Aluminum dividing channels, 122, 123
 Aluminum trihydrate (ATH), 132, 141
 American/European hybrids, 52–59
 Athion, 136
 Avonite, 141, 142

B

Back panels, 44
 Backer strips, 20
 Backsplash, 151
 Band clamps, 95
 Base cabinets
 European, 22–23
 installation of, 15–20, 58–59,
 62–66, 79
 manufactured, 6–9
 sink, 19–20, 64, 87
 site-built, 74–81
 Birch plywood, 30, 42–45, 76–81
 Biscuit joints
 for face frame cabinets, 72
 for laminate countertops, 110–11
 for partitions, 86–87
 for raised panels, 49
 for solid-surface tops, 143–44, 145
 Blind corners, 31, 58, 59
 Blum drilling fixture, 57
 Blum hardware, 10, 56
 Bolts, countertop, 110–11
 Brad-point drill bits, 105
 Bullnose edging, 117, 119, 147
 Butcher block countertops, 129
 Butt hinges, 13
 Butt joints, 118–19

C

Cabinet jacks, 21
 Cabinets
 American/European, 52–59
 categories of, 4–6
 corner, 16–17, 18, 62, 87, 90–97
 cost of, 6
 European, 22–23, 52–59, 74
 heart pine, 68–73
 inexpensive, 7
 inside look at, 4–13
 joining, 18–19
 manufactured, 4–13
 MDF, 46–51
 melamine, 6–7, 98–105
 refrigerator, 63
 saving old, 30
 semicustom, 4, 6, 8, 9
 sink base, 19–20, 64, 87

site-built, 74–81, 84–85
 stock, 4, 8
 upper, 15–16, 20–21, 22, 59, 66–67
 veneer refacing for, 26–35
 where to buy, 11
 See also Base cabinets; Custom
 cabinets; Installation

Carcase

32mm system, 53, 55–57, 58
 assembly, 58
 baltic birch plywood, 76–78
 in custom cabinets, 9
 in inexpensive cabinets, 7, 8
 in semicustom cabinets, 8
 site-built, 84
 in stock cabinets, 8
 Carousels, 91–97
 Cellulose-paper overlays, 100
 Ceramic tile countertops, 131
 Certification, 6, 11
 Chamfer, 118
 Cheng, Fu-Tung, 120–27
 Circular pieces, 92–94
 Clamps, band, 95
 Clip-style hinges, 74
 Composite countertops, 136–37
 Concepts in Wood, 28
 Concrete countertops, 120–27, 130
 concrete mix for, 126
 mold for, 120–25
 pouring, 127
 reinforcement for, 126
 Contact cement, 114–15
 Cope-and-stick joints, 12
 Corian, 132, 140
 Corner cabinets, 16–17, 18
 blind corner, 31, 58, 59
 lazy Susan, 62, 90–97
 sink base, 87
 Corner shelves, 31, 58, 59
 Cornstarch, 142
 Countertop bolts, 110–11

Countertops

butcher block, 129
 ceramic tile, 131
 choosing, 128–39
 composite material, 136–37
 concrete, 120–27, 130
 for European cabinets, 23
 granite, 128, 134–35
 hardwood edging for, 116–19
 height of, 15
 laminate, 108–15, 128, 138
 site-built, 89
 slab stone, 134–35
 solid-surface, 132, 140–51
 stainless steel, 133
 Crown molding, 35
 Cup hinges, 13, 39, 57, 74, 80–81, 101
 Custom cabinets, 6, 9
 American/European, 52–59
 frameless, 36–45, 74–81
 framing in place, 85–86

heart pine, 68–73
 lazy Susan, 90–97
 MDF traditional look, 46–51
 site-built, 74–81, 82–89

D

Dado blades, 77–78, 102
 Dadoes, 43, 102
 Dividing channels, aluminum, 122, 123
 Doors
 baltic birch plywood, 81
 construction of, 12–13
 in custom cabinets, 9
 frame-and-panel, 12, 36, 37–42,
 47–51
 glass panel, 55
 heart pine, 71–73
 in inexpensive cabinets, 7, 8
 inset, 12
 installation of, 67, 81
 for lazy Susan cabinets, 90, 91
 MDF, 49–51
 overlay, 12–13, 54
 raised panel, 12, 48, 49–51, 69–71
 in semicustom cabinets, 8
 site-built, 89
 solid wood, 8, 9, 12
 in stock cabinets, 8
 thermofoil, 12
 Dovetail joints, 10
 Dowels, 10
 Drain board, 123
 Drawer fronts, 35, 45, 51, 54, 81
 Drawer slides, 9–11
 clearances for, 45
 full-extension, 11
 installation of, 88
 three-quarter extension, 11
 undermount, 10, 11
 wooden, 86
 Drawers
 American/European, 57–58
 construction of, 9–11
 in custom cabinets, 9
 engineered wood, 11
 hardwood, 8, 9, 11
 in inexpensive cabinets, 7, 8
 installation of, 35
 melamine, 10, 11
 saving old, 30
 in semicustom cabinets, 8
 site-built, 89
 in stock cabinets, 8
 tongue-and-dado joints for, 45
 Drill bits, brad-point, 105
 Drill press, 80, 81
 Drilling
 melamine, 105
 templates, 25, 56–57, 105

E

Edgebanding machine, 56

Edging

- bullnose, 117, 119, 147
- for carousels, 94–95
- for frameless cabinets, 74, 76
- hardwood, 44–45, 116–19
- for laminate, 113–14, 116–19
- for melamine, 102–105
- particleboard, 111–12
- profiles, 117
- rabbeted, 39, 102, 105–107
- for site-built cabinets, 89
- for solid-surface tops, 146–47
- trimming, 118

End panels, plywood, 30, 32

Engineered wood drawers, 11

European cabinets

- American hybrids, 52–59
 - cup hinges for, 74
 - installation of, 22–23
- See also Base cabinets

F

Face frame cabinets

- biscuit joints for, 72
- finishes for, 34
- manufactured, 6, 8
- MDF, 47, 48

Fasteners, 53, 58, 101

Faucet knockouts, 125

Fiber-cement countertops, 137

Filler strips, 20, 65

Finishes, 34, 57, 73, 95

Finnerly, Ann, 133

Fluoropolymers, 135

Foils, 100, 101–102, 107

Frame-and-panel doors, 12, 36, 38, 47–51

Frameless cabinets

- edging, 74, 76
- manufactured, 6
- melamine, 7
- site-built, 74–81
- tongue-and-dado joints for, 42–45
- traditional look, 36–45

Full-extension drawer slides, 11

Full overlay doors, 12

G

Gibson, Scott, 4–13

Glass panel doors, 55

Glue

- for hardwood edging, 117
 - hot-melt, 144
 - melamine and, 101, 105–107
 - resin and, 71
 - for solid-surface tops, 144–46, 150–51
 - squeeze-out, 146
- Goldman, Jay, 46–51
- Granite countertops, 128, 134–35
- Grout, 131

H

Half-moon shelves, 58

Handles, 25

Hardware, 25, 96–97

Hardwood

- drawers, 8, 9, 11
- edging, 44–45, 116–19
- plywood, 30, 42–45, 53, 76–78, 84, 92, 99

Heart pine cabinets, 68–73

High-pressure laminate (HPL), 99, 100, 138

Hinges, 12–13

- butt, 13
- clip-style, 74
- cup, 13, 39, 57, 74, 80–81, 101
- for veneer refaced doors, 35

Hole-drilling template, 105

Hueston, Fred, 134–35

Hydrocote finishes, 34, 57, 73

I

Impregnators, 135

Inexpensive cabinets, 7–8

Inset doors, 12

Installation, 14–25, 60–67

- of American/European hybrids, 58–59
- of base cabinets, 15–20, 58–59, 62–66, 79
- of doors, 67, 81
- of drawers, 35, 88
- of European cabinets, 22–23
- of hardware, 25
- of islands and peninsulas, 24–25, 65–66
- marking the layout, 14–16, 61
- screws for, 18
- scribing for, 17–18, 20, 63–65
- of shelves, 88
- shimming for, 17
- of sink base cabinets, 19–20
- of toe-kicks, 35
- of upper cabinets, 15–16, 20–21, 59, 66–67, 81
- of veneer refacing cabinets, 31–32
- between walls, 20

Ironing

- polymer tape, 104–105
- veneer, 32–34

Islands, 21, 23, 24–25, 65–66

J

Jacks, cabinet, 21

Jigs and templates

- for circular pieces, 92–93
- for concrete countertops, 120–22
- drilling, 25, 56–57
- mirror, 143–44
- for plunge-router mortises, 40–41
- for solid-surface tops, 141–42

Joints

- butt, 118–19
- cope-and-stick, 12
- dado, 43, 102
- dovetail, 10
- loose-tenon, 37–38

miter, 12, 117–18

tongue-and-dado, 42–45

tongue-and-groove, 77–78, 89

See also Biscuit joints

K

Kadama wood, 53

Kimball, Herrick, 28–29

Kitchen Cabinet Manufacturers Association, 6, 11

Kitchen cabinets. See Cabinets

Kitchen Kompact, 8

Knockdown fasteners, 53, 58

KraftMaid Cabinets, 4, 8, 9, 12

L

Laminate

- applying, 113–15
- countertops, 108–15, 128, 138
- decorative panels, 100–101
- edging for, 113–14, 116–19
- high-pressure (HPL), 99, 100, 138
- style and colors, 109
- substrate for, 109–12

Laminate saw blades, 102

Laminate trimmer, 113, 115

Lanza, Joseph B., 74–81

Lava countertops, 136, 137

Law, Tom, 14–25

Layout

- cabinet, 84–85
 - installation, 14–16, 61
- Lazy Susan cabinets, 62, 90–97
- Lead strips, self-adhering, 55
- Leg levelers, 56
- Levine, Paul, 116–19
- Longleaf pine cabinets, 68–73
- Loose-tenon joints, 37–38

M

Magic Wand, 57

Manufactured, cabinets, 4–13

Maple, 53, 94–95

Maple plywood, 53, 84, 92

Markcrow, Daphne, 135

Marking layout, 14–16

MDF (Medium-density fiberboard), 12, 46–51, 49–51, 125

Melamine

- cabinets, 6–7, 98–105
- concrete countertop mold, 122
- drawers, 10, 11
- drilling, 105
- fasteners for, 101
- scratches and blemishes in, 107
- table saw for, 91, 102
- thermofused, 99–102

Micropaper, 100

Mirror jigs, 143–44

Miter joints, 12, 117–18

Molder/planers, 49

Molding, 35, 42

Morris, Steve, 108–15

Mortising, 37–38, 40–41

Mounting rail, 18

N

Nosings, 119, 141

O

Olsen, Eric, 120–27

Overlay doors, 12–13, 54

P

Panel molding, 42

Panel-raising bits, 71

Panels, 12, 44, 48, 49–51

See also Frame-and-panel doors

Particleboard

drawers, 11

manufactured cabinets, 6–7

substrate, 101, 109–12

Partitions, 86–87

Peninsulas, 23, 24–25, 65–66

Pilot holes, 105

Pine cabinets, 68–73

Pivoting blind corner shelves, 31

Planer, 38

Plastic laminate. See Laminate

Plunge router, 37–38, 40–41

Pluswood Indiana, 30

Plywood

birch, 30, 42–45, 76–81

cabinets, 48

carousels, 91–97

drawers, 11

edging, 56

end panels, 30, 32

hardwood, 30, 99

hardwood edging for, 44–45

laminated, 117

maple, 53, 84, 92

props, 21

table saw ripping, 91

veneer-core, 7, 8

Polymer tape, 104–105

Polyurethane, 73

Props, plywood, 21

Putty, colored, 59

Pyrolave, 136

Q

Quarter-round router bits, 118

Quartz composites, 136, 137

R

Rabbets, 39, 102, 105–107

Radial arm saw, 83

Rails, 29, 32–34, 49

Raised panel doors, 12, 48, 49–51, 69–71

Raised panel sides, 49–51

Rebar, 126

Red oak plywood, 30

Refrigerator cabinets, 63

Reinforcing mesh, 126

Resin, 71, 100–101, 132

Resin composites, 136, 137

Round-over router bits, 119, 147

Router

for circular pieces, 92–93

for glue squeeze-out, 146

for hardwood edging, 118

for heart pine, 69–71

for laminate, 113, 115

for melamine edges, 102–104

for mortising, 37–38, 40–41

for rabbeted edge, 39

for raised panel doors, 69–71

for solid-surface tops, 143, 147

zero-clearance fence, 70

Router bits

laminate, 113

panel-raising, 49, 71

quarter-round, 118

round-over, 119, 147

shanked, 143

Rutt Custom Cabinetry, 4, 9

S

Sanding

heart pine, 71

scuff, 32

solid-surface tops, 147, 148

veneer, 34

Santarsiero, Tom, 22–23

Saw blades

dado, 77–78, 102

laminate, 102

for melamine, 102

triple-chip grind, 142

Screws, 18

Scribing, 17–18, 20, 63–65

Scuff sanding, 32

Sealers, penetrating, 135

Semicustom cabinets, 4, 6, 8, 9

Shanked router bits, 143

Sheet goods, 6–7

Shelf supports, 105

Shelves, 7, 8, 9

half-moon, 58

installation of, 88

pivoting blind corner, 31

Shimming, 17

Sides, raised panel, 49–51

Silestone, 136

Simmonds, Tony, 82–89

Sink base cabinets, 19–20, 64, 87

Sink knockouts, 123–24

Sink solid-surface countertops, 148–50

Site-built cabinets, 74–81, 82–89

Slab stone countertops, 134–35

Slate countertops, 135

Soapstone countertops, 135

Solid-surface countertops, 132, 140–51

backsplash for, 151

edging for, 146–47

gluing, 144–46, 150–51

joining, 143–44

sinks in, 148–50

support for, 150

table saw ripping, 142–43

templates for, 141–42

Southern yellow pine, 68

Squeeze-out, 146

Stainless steel countertops, 133

Stiles

joining, 18–19

MDF, 49

veneering, 28–29, 32–34

wider, 20

Stock cabinets, 4, 8

Stone countertops, 134–35

Story pole, 76

Substrate, particleboard, 101, 109–12

T

Table saw

for baltic birch plywood, 76

for dados, 43

for hardwood edging, 116–17

for melamine, 91, 102

for plywood ripping, 91

for site-built cabinets, 83

for solid-surface tops, 142–43

for tenons, 38

for tongue-and-groove joints, 77–78

Tape, polymer, 104–105

Templates. See Jigs and templates

Tenons, 38

Thermofoil doors, 12

Thermofused melamine, 99–102

32mm system, 52–59, 74

Toe-kicks, 23, 35

Tongue-and-dado joints, 42–45

Tongue-and-groove joints, 77–78, 89

TopLab, 136

Traditional look frameless cabinets, 36–45

Trammels, 92–93

Triple-chip grind saw blades, 142

U

Undermount drawer slides, 10, 11

Upper cabinets, 15–16, 20–21, 22, 59, 66–67, 81

V

Varnish, solvent-based, 7

Veneer

applying, 32–34

for carousel edges, 95

hot-melt glue strips, 89

pressure-sensitive, 28–29

refacing for cabinets, 26–35

sanding, 34

sources of, 28, 31

Veneer-core plywood, 7, 8

Venetian blind slats, 113, 115

W

Wall cabinets. See Upper cabinets

Water-based finishes, 34

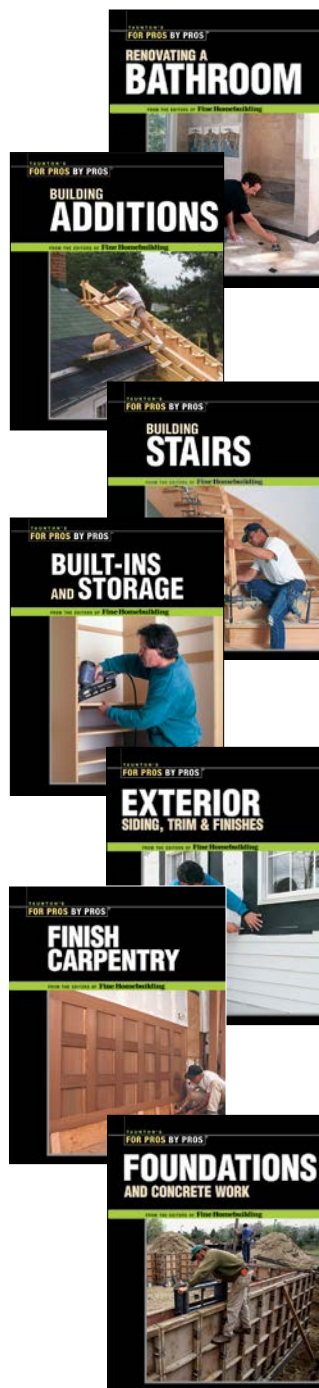
Web sites, 11

Z

Zero-clearance fence, 70

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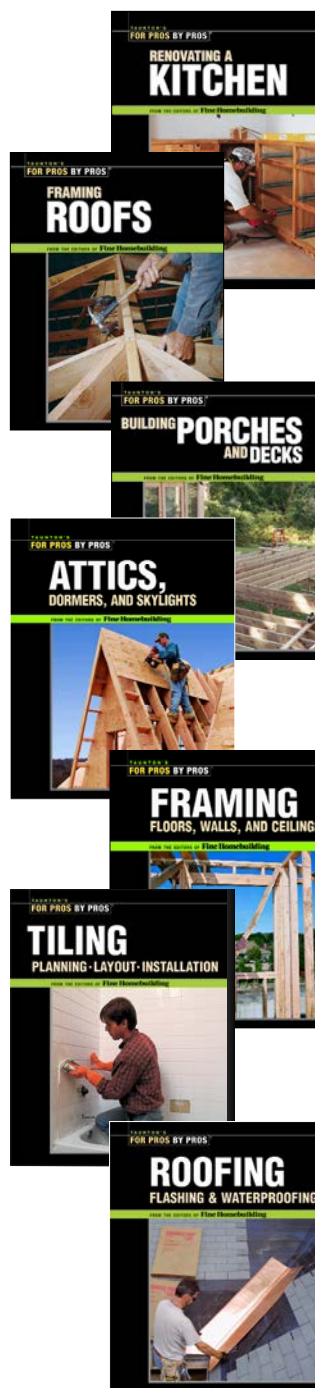
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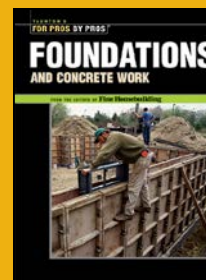
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